

**THE IMPACT OF THE NATIONAL CURRICULUM STATEMENT PRINCIPLE IN TEACHING
OF PHYSICAL SCIENCE IN GRADE 10 TO 12 AROUND SEKHUKHUNE DISTRICT**

BY

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DECLARATION

Student Number: 3647-385-5

I declare that **The impact of National Curriculum Statement principle in teaching of physical sciences in grades 10 to 12 around Sekhukhune District** is my own work and that all the sources that I have used or quoted have been duly acknowledged and indicated by means or complete references.

This research report has not been previously submitted in part or in full for any other degree to another university.

.....

February 2013

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(Researcher)

DEDICATION

I dedicate this dissertation to my family for their continued moral support during my studies.

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ABSTRACT

The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence as defined in the National Qualifications Framework (NQF) (Department of Education 2003:3). Physical science underperformance has plagued out Further Education Training (FET) schools sector for some time and therefore this study which is directed at the possible causes of poor performance and to devise strategies that could assist physical science teachers to teach more effectively addresses a crucial gap in the performance of the country's education provision. Emanating from the above, this study focused on the impact of National Curriculum Statement principle in the teaching of physical science in Grades 10 to 12 around Sekhukhune district.

The study looked at integration as a principle endorsed in the National Curriculum Statement and how this is implemented by teachers in the teaching of physical science in grades 10-12. A literature study on the impact of National Curriculum Statement principle in the teaching of physical science was undertaken. A qualitative approach was used to obtain data from Grades 10-12 teacher in FET around Sekhukhune district. Data were collected in the form of participant observation, semi-structured and focus group interviews. The results indicate that teaches had no clear idea of integrating the relevant concepts in the subjects they were teaching (physical science). It was also found that teachers did not receive adequate in-service training specifically targeting the principle of integration. The study recommends the professional development of physical science teachers.

The study indicated that the continuum model of integration is suitable for the implementation of concepts integration. It is believed that if the continuum model of integration could be used and followed by teacher as a guiding principle in the integration process, the challenges experienced by teachers in this regard will be minimized.

Key words: Integration; Implementation; National Curriculum Statement; Physical Science.

LIST OF ABBREVIATIONS

AAAS	American Association for Advancement of Science
Ass	Assessment Standards
C2005	Curriculum 2005
CAPS	Curriculum and Assessment Policy Statement
DoE	Department of Education
FET	Further Education and Training
GET	General and Education Training
HE	Higher Education
LO	Learning Outcome
LOLT	Language of Learning and Teaching
LTSM	Learner Teacher Support Materials
M	Mathematics for the sake of mathematics
MS	Mathematics and Science
Ms	Mathematics with science
NCS	National Curriculum Statement
NCTM	National Council of Teachers of Mathematics
NQF	National Qualification Framework
NRC	National Research Council

OBE	Outcomes-Based Education
RNCS	Revised National Curriculum Statement
S	Science for the sake of science
SAQA	South African Qualification Authority
SKVAs	Skills, Knowledge, Values and Attitudes
Sm	Science with mathematics
SMT	School Management Team
SSMA	School Science and Mathematics Association
UIC	University of Illinion at Chicago

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter explains the background, the study problem as well as the goal and objectives of the study. The chapter further describes related literature used in the study, the research methodology followed, measures to ensure trustworthiness and the ethical considerations. It concludes by explaining the limitations of the study, concepts used in the study and highlights the overview of chapters covered by the study.

The adoption of the Constitution of the Republic of South Africa (Act 108 of 1996) provides a basis for curriculum transformation and development, which aims to heal the division of the past and establish a society based on democratic values, social justice and fundamental human rights (Department of Education 2003:1). The following are among the principles guiding our development according to the National Curriculum Statement (Department of Education 2003:3):

- Social transformation which aims to redress the education imbalances.
- Integration and applied competence which aims to promote an integrated learning of theory, practice and reflection.

Integrated learning is an approach that seeks to make learning 'whole' and is based on a holistic view of education. "It recognizes the necessity to see the 'big picture' rather than to require learning to be divided into small pieces (Brazee & Capelluti, 1993 cited in Brazee & Capelluti, 1995:10).

The principle of integrated learning is integral to Outcome-Based Education (OBE); therefore, the National Curriculum Statement (NCS) promotes integrated learning. This means that learning should not be remote and compartmentalized, it has to be combined. The emphasis is on the relationship between practice, theory and reflection and links between one subject and others. Integration across subjects is also encouraged where it makes sense and assists with the development of applied competence. In making the learning experience at school 'whole' through integrated learning, a learner's outlook of the larger world can be also made 'whole'. Learning to see the interconnections of all aspects of life ultimately becomes a habit-of-mind that will serve them well throughout their lives.

The study focuses on the impact of integration as one of the principles of the NCS in the teaching of physical science in Grades 10-12 around Sekhukhune District, Limpopo Province, South Africa. The community around Sekhukhune area perceives that physical science is a difficult subject; it is for the intellectually gifted; and it is extremely difficult for a learner to achieve good results in physical science that will lead him/her to enter professions such as medicine, engineering or other related professions. Traditionally, teachers' professional development takes place through workshops. After workshops, teachers return to their school and may not use what they have learned during the workshops. Most teachers around Sekhukhune District are informed of the NCS but the implementation of integration as a principle of the NCS in the teaching and learning of physical science in the classroom is still a challenge.

Research indicates that the use of an integrated curriculum provides opportunities for more relevant, less fragmented and more stimulating experiences for learners (Frykholm & Glasson 2005; Jacobs 1989; Koirala & Bowman 2003).

1.2 Problem statement

The NCS is transformational when compared to other curricula development in South Africa. According to Brodie, Lelloit and Davis (2002:541), there has been a strong shift in education policy from the teacher-centered to the learner-centered approach in the South African education system. Given the shift, it appears that teachers may create a gap between policy and procedures. However, the NCS emphasizes that integration is achieved within the subject and across the subject in the field of learning.

Based on the given information, it is assumed that teachers are not able to integrate concepts and are unfamiliar with the principle of integration as stated in the NCS policy document. This is evident from the Limpopo Provincial National Senior Certificate Examination Results report of 2010. According to the report (2010), learners who study physical science as a subject perform poorly. This performance was analysed for a period of three years and the average for the National Senior Certificate results in physical science are as follows:

- 2008 = 54, 9%;
- 2009 = 36, 8%;
- 2010 =47, 8%.

Although a slight improvement of physical science performance in 2010 as compared to 2009 is noted, there is still a drop in the overall performance as compared to 2008 results. The analysis indicates that learners who study physical science in Limpopo Province perform poorly.

In light of the given problem the main research question in this study is:

What is the impact of integration in the teaching of physical science in Grade 10-12?

To address this phenomenon, the following sub questions are considered:

- Do teachers integrate concepts within and across their subjects?
- To what extent have physical science concepts been integrated to other subjects?
- What are the challenges experienced by physical science teachers in the integration processes?

1.3 Research goal and objectives

The purpose of this study is to investigate the impact of integration in the teaching of physical science in Grades 10-12. Given this aim, the following objectives need to be achieved:

- To determine whether teachers are integrating concepts within and across the subjects.
- To explore the extent to which physical science concepts have already been integrated to other subjects.

- To investigate the challenges experienced by physical science teachers in the integration process.

1.4 Motivation and rationale

The researcher of this study has been a physical science teacher for the past ten years. During her teaching experience she observed the unsatisfactory performance of learners in physical science. This fact was also highlighted by the Limpopo Province Minister of Education, Namane Masemola, in his report of the physical science results in 2009. The report showed that the physical science pass average provincially was 31, 8%; in the Sekhukhune District the average was only 24,1%. Moreover, certain schools in the Sekhukhune District obtained 0% in physical science. This report as well as personal observance motivated this study to investigate possible causes of this poor performance and to devise strategies that could assist physical science teachers to teach the subject more effectively. It is believed that the findings of this study will benefit physical science subject specialists, physical science teachers and learners who intend pursuing their careers in the field of sciences.

1.5 Review of related literature

Integration is the process of bringing different parts together to combine into a whole (Shelley, Cashman, Gunter & Gunter 2008:327). Several studies (Frykholm & Glasson 2005; Jacobs 1989; Koirala & Bowman 2003) indicate that using an interdisciplinary or integrated curriculum provides opportunities for more relevant, less fragmented and more stimulating experiences for learners.

Frykholm and Glasson (2005:130) state that interdisciplinary teachings include the assumption that the integrity of disciplinary boundaries will be preserved through exploration of common contexts that promote learning of both science and mathematics. Such a view predicates that teachers have both the content knowledge and pedagogical content knowledge to teach two disciplines (science and mathematics) successfully. Frykholm and Glasson (2005:130) further explain that 'integrated' teaching implies that science and mathematics can be blended seamlessly so that it is difficult to tell where the mathematics stops and Science begins.

In the same vein, Jacobs (1989:6) states that a knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic or experience is called interdisciplinary. He further considered the following beliefs and assumptions (Jacobs 1989:7):

- To avoid the potpourri problem, teachers should be active curriculum designers and determine the nature and the degree of integration and the scope and sequence of the study;

Curriculum making is a creative solution to a problem; an interdisciplinary curriculum should be used when the problem reflects the need to overcome fragmentation, relevance and the growth knowledge.

Finally, Koirala and Bowman (2003:145) state that many members of the mathematics and science education community believe that the integration of mathematics and science enhances learner understanding of both subjects.

According to the National Council of Teachers of Mathematics (2000:66), processes and content of science can inspire an approach to solving problems that applies to the study of mathematics. Similarly, the National Research Council (1996:214) states that the sciences programme should be coordinated with the mathematics programme to enhance learner use and understanding of mathematics in the study of science and to improve learner understanding of mathematics.

In support to the given views, Czernaik, Weber and Sandman (1999:421) state that curriculum integration also serves as a cornerstone of the move towards creating schools that focus on the needs and interests of the learners. It is also argued that integration or content areas can help learners learn to think critically and help develop a common core of knowledge necessary for success in the next century. Learners also need open-ended opportunities to integrate their knowledge and skills from different disciplines and, importantly, to think critically about how all of those pieces fit together.

Additionally, Lonning and DeFranco (1997:213) highlight that the concept integration is used to describe the nature of the relationship between two or more disciplines which are included in an interdisciplinary unit. The concept of integration becomes especially important at the level of specific activities. For example, in a possible thematic unit, mapping is a key to understand our world as it could contain a variety of activities designed to meet goals and objectives in science and mathematics and could be related to each other in a variety of ways.

Hargreaves (2000:284-285) advocates the notion of team or group work, as it does not only promote a good relationship between role players, but also leads to coordination of activities. In groups teachers or learners can solve emerging problems collaboratively. Furthermore, when teachers or learners are exchanging their experiences and sharing expertise or practice, they grow professionally (Bubb & Earley 2004:89-97; Fullan 2001:253-266).

Mampuru (cf. Ndou 2008:34) perceives implementation as the most difficult phase of the change process as most shortcomings of the change may appear at this stage. This confirms Fullan's (1992:24) assertion that the early implementation of change is inevitably fraught with difficulties. Furthermore, Ramroop's (2004:5) standpoint is that the implementation of a change impacts significantly on people and institutions and, if not administered correctly and sensitively with lot of skill and support, good ideas may become unachievable. Moreover Pontenza and Monyokolo (cf. Saib 2004:3) posit that most implementation-bound challenges have their origin in lack of alignment between curriculum development, teacher development and selection and supply of learning materials.

When a policy like the NCS is implemented in schools, both experienced and inexperienced teachers need to get used to it and be trained for the new system (DoE 2000a:15). In support of this notion, Ramroop (2004:5) states that if people who need to be the driving force behind the change are not fully equipped with knowledge, skills and attitude of being a positive force of change, then any change attempt is sure to fizzle out. Van der Merwe (2002:32) contends that teachers are more likely to respond positively to initiatives if they are given additional support during its planning and developmental stages.

According to Serrao (2008:1) and Kgosana (2006:1), poor teacher training is a significant challenge that hampers the successful implementation of the NCS in secondary schools. Most teachers who are currently in the system received their baseline professional training under the auspices of the old apartheid curriculum. Therefore, they are most likely to experience difficulties in implementing a new curriculum effectively. Specifically, these challenges relate to content knowledge and skills to teach in the OBE way. Against this background, the focus of this study is the in-service teacher training and not necessarily the teacher's formative training that teachers receive in preparation of the implementation of curriculum change.

The NCS sees integration as a key principle, and integration is achieved within and across subjects and fields of learning (DoE 2003:3). In this study, integration of physical science, mathematics and life sciences was explored. Research indicates that using an integrated curriculum provides opportunities for a more integrated curriculum which is relevant; less fragmented and provides a more stimulating experience for learners (Frykholm & Glasson 2005:127-141).

1.6 Research methodology

The research methodology adopted in this study is qualitative in nature. Qualitative research describes the depth, richness, and complexity inherent in the phenomena and involves putting pieces together to understand the whole (Burns & Grove, 2003:357). The qualitative approach is based on the world view that there is no single reality, perceptions differ from person and over time and what is known has meaning only within a given context (Burns & Grove, 2003:357). The researcher wants to adopt a person-centred and holistic perspective to understand the human experience, without focusing on specific

concepts. The original context of the experience is unique, and rich knowledge and insight can be generated in depth to present a lively picture of the participants' reality and social context (Holloway 2005:4). These events and circumstances are important to this research. During the interaction between the researcher and research participants, the participants' world is discovered and interpreted by means of qualitative method (De Vos 2002:360).

1.6.1 Research design

A research design is a blueprint for conducting a study that increases the probability that the study findings are a true reflection of reality (Burn & Grove, 2003:195). In addition Yin (2003:20) asserts that the research design is the logical sequence that connects the empirical data to the study's initial research questions and ultimately, to its conclusion. The main purpose of the research design is to help to avoid the situation in which the evidence does not address the initial research question.

In this study the researcher employed phenomenological design to collect and analyse data. Phenomenology is a science whose purpose is to describe particular phenomena, or the appearance of things, as lived experiences (Streubert & Carpenter 2002:56). Thus, phenomenology is an attempt to describe lived experiences without making previous assumptions about the objective reality of those experiences (Holloway 2005:47). Phenomenological research further examines the particular experiences of unique individuals in a given situation, thus exploring not what is (reality), but what it is preconceived to be (Burns & Grove 2003:360). In this study phenomenology is used to understand lived experiences of teachers teaching physical sciences using integration as a key principle of the NCS.

1.6.2. Population

The research population is the entire set of individuals that meets the same criteria of the study (Burns & Grove, 2003:233). The population of this study was all teachers working in schools in Sekhukhune district offering physical science as a subject in the Limpopo Province.

1.6.3 Sampling

Purposeful sampling was used in this study, to learn the most from relevant people. The researcher's judgment about the selection of the sample was influenced by the information obtained from the school results on physical science. The sample of the study is therefore made up of eight schools and eight teachers selected from each of the participating schools (i.e., one teacher per school).

1.6.4 Data collection strategies

Data collection took the form of a brief participant observation, a focus group interview and semi-structured interviews for obtaining information from the teachers based on their experiences of the implementation of the NCS policy in the classroom.

1.6.4.1 Participant observation

Participant observation is defined as a procedure of recording and observing conditions, events, feelings, Physical settings and activities through looking rather than asking (Denzin & Lincoln 2000:673; Walliman 2006:95). Meanwhile

other researchers (Alston & Bowles 2003:196; Dane 1990:158-160; Gravetter & Forzano 2003:462; Marlow 2005:338) suggest that researchers become part of the situation and submerge themselves in order to become part of the group, but at the same time nothing should be changed in that situation. The study used participant observation as the researcher is also a physical science teacher. For the purpose of this study observation were conducted in eight selected secondary schools in Sekhukhune District, Limpopo Province.

1.6.4.2. Semi-structured interviews

The semi-structured interview is the interview where the researcher wants to gain a detailed picture of a participant's beliefs about or perceptions or accounts of, a particular topic. For this reason the researcher is able to follow up particular interesting avenues that emerge in the interview, and the participants are able to give a fuller picture (De Vos 2011:351). The researcher in this study wanted to gain a detailed picture of the perceptions of teachers about the teaching of physical science following the NCS policy. The advantage of this approach is that it facilitates probing and clarity.

1.6.4.3 Focus group

Kingry, Tiedjie and Friedman (1990:124) define a focus group interviews as a carefully planned discussion designed to obtain perception on a defined area of interest in a permissive, non-threatening environment. Additionally Morgan (1997:6) describes the focus group interviews as a research technique that collects data through group interactions on a topic determined by the researcher.

In this study, a focus group interview was conducted to ensure that the discussion that took place was limited to the specific theme under investigation. The impact of integration as the NCS principle in teaching physical science was discussed in focus group interview. In addition, it enabled the researcher to accumulate multiple viewpoints in a short space of time.

1.7 Data analysis

Data were analyzed through a simple qualitative analysis method. According to McMillan and Schumacher (2001:462), qualitative analysis is an ongoing process integral into all phases of qualitative research. It is a systematic process of examining, selecting, categorizing, comparing, synthesizing and interpreting data to address the initial proposition of the study (Yin2003:109; White 2002:82; Leedy & Ormrod 2001:150). Babbie (2007:378) defines qualitative analysis as the “nonnumeric examination and interpretation of observation, for the purpose of discovering underlying meanings and patterns of relationship”. On the other side Gibbs (2007:1) states:

...the idea of analysis implies some kind of transformations. You start with some (often voluminous) collection of qualitative data and then process it, through analytic procedures, into a clear, understandable, insightful, trustworthy and even original analysis.

The researcher also followed Marshall and Rossman's guidelines of data analysis. Marshall and Rossman (1999:152-159) highlighted the following guidelines:

- Planning for recoding data
- Data collection and preliminary analyses

- Managing or organizing of data
- Reading and writing memos
- Generating , categorizing, themes and pattern
- Coding data testing the emergent understanding
- Searching for alternative explanations
- Representing, visualizing (that is writing the report)

1.8 Measures to ensure trustworthiness

De Vos (2005:346) argues that the verifiability of qualitative research is accurately assessed according to its trustworthiness. In this study, Lincoln and Guba's model for ensuring the trustworthiness of qualitative data was employed. In accordance with this model, four criteria were used to ensure trustworthiness, namely truth-value; applicability; consistency and neutrality as explained in detail in chapter 3 paragraph 3.4.

1.9 Ethical considerations

In this study, the researcher hopes to observe and uphold critical research principles.

Since the study includes participant observation, focus group and semi-structured interviews of teachers during school hours, the researcher obtained permission from the Sekhukhune Department of Education Manager as well as the principals of selected schools around Sekhukhune District. The participants were made aware that although their participation was valued, their roles were voluntary and they were at liberty to withdraw should they feel uneasy in the process of the study. A commitment was also undertaken to conceal the names of the participant and those of the institution to which they were attached.

Instead code names were used. The findings of this study will be made available to the participants on request after the examination process.

1.10 Limitation of the study

Given the study background and the purpose of the study, this study has the following limitations:

- The study only focuses on the impact of integration in the teaching of physical sciences in Sekhukhune District.
- Not all secondary schools were selected to participate in the study; only those who offer physical science as a subject were selected.
- Only physical science teachers participated in the study.
- Typical of a qualitative study using a small sample, the findings may not be generalized.

1.11 Concept clarification

In an attempt to eliminate any misconceptions that might occur from the meanings attached to the individual terms used in the title of the study, it is critical to establish the scientific views linked to each of the following terms:

1.11.1 Implementation

Ornstein and Hunkins (1998: 292) define implementation as an interaction process between those who have created the programme and those who are charged to deliver it. It means getting teachers to shift from one programme to the other programme.

1.11.2 Integration

Integration is a key design principle of the Revised National Curriculum Statement Grades R-9 (schools) that requires learners to use their knowledge and skills from other subjects from different parts of the same subject, to carry out tasks and activities (www.sahistory.org.za/article/classroom.draft).

1.11.3 National Curriculum Statement

The National Curriculum Statement represents a policy statement for learning and teaching in South African Secondary Schools located in the Further Education and Training band. It replaces “A Resume of Instructional Programmes in Schools Report 550 (2001/08)” as the document that stipulates policy on curriculum and qualifications in Grades 10-12 (DoE 2003: vii)

This new curriculum for the Grades 10-12 is currently being implemented in secondary schools in South Africa.

1.11.4 Teacher

A teacher is a person who helps learners to acquire knowledge, skills and values in a formal teaching environment such as school (Ngcongco 2000:2). The National Curriculum Statement policy (DoE 2003:5) visualises teachers who are qualified, competent, dedicated and caring to fulfill the various roles outlined in the Norms and Standards for Educators.

1.11.5 Physical science

Physical science is any of the natural Sciences (as Physics, Chemistry and Astronomy) that deal primarily with nonliving materials (Merriam Webster dictionary). According to Department of Basic Education (2011:8) physical science investigates Physical and Chemical phenomena. This is done through scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the Physical environment. This subject also deals with society's need to understand how the Physical environment works in order to benefit from it and responsible care for it.

1.11.6 Secondary schools

In the South African context secondary schools refers to the formal category of school level that offers education to Grades 10; 11 and 12 learners. These Grades are classified as the Further Education and Training (FET) band.

FET band can be described as all learning and training programmes leading to qualifications from level 2 to 4 of the National Qualification Framework (NQF) as contemplated by the South African Qualification Authority Act (SAQA) in 1995. It is located between General and Higher Education Training, alongside the world of work (DoE 2003: viii)

1.11.7 Curriculum

Schubert (1986:26-28) states that the curriculum can be perceived as content, as programme of planned activities, as intended learning outcomes, as cultural reproduction, as experiences as discrete concepts to be mastered or as an

agenda for social reconstruction. Curriculum is a point at which knowledge, the interrelationships between teachers and learners, the economy and political and social structures of society intersect and interact.

1.11.8 Outcomes Based Education

Outcomes-Based Education (OBE) is a curriculum approach to teaching and learning that requires a shift from teacher input through syllabuses to focus on learners' outcomes (DoE 2003:3)

1.11.9 Revised National Curriculum Statement (RNCS)

Revised National Curriculum Statement (RNCS) is a revised version of the National Curriculum Statement (NCS) (DoE 2002:8). RNCS is therefore not a new curriculum statement but streamlined and strengthen Curriculum 2005.

1.12 Overview of chapter to follow

Chapter 2: This chapter focuses on the review of literature on the impact of integration as a principle of the National Curriculum Statement in the teaching of physical science. The chapter also explains the continuum models of integration.

Chapter 3: This chapter explains the research methods and design applied in the study. It further explains the measures to ensure trustworthiness as well as the research ethics.

Chapter 4: This chapter presents the analysis and interpretation of data collected through the observations, semi-structured and focus group interviews.

Chapter 5: This chapter focuses on the main findings and conclusions of the study as well as the recommendations for further research.

1.13 Conclusion

The background of the study context was explained. The problem of the study as well as the aim and objectives of the study were described in the chapter. The chapter concluded by explaining the research methodology applied in the study, the ethics, and measures of trustworthiness as well as providing a brief description of the organisation of the study. In the next chapter, literature pertaining to integration as a principle of the NCS is reviewed.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A literature review is a thoughtful and informed discussion of relevant literature that builds a logical framework for the research that sets it within the context of relevant studies (De Vos, 2005:123). The process of reviewing literature involves findings, reading, understanding and forming conclusions about published research and presenting it in an organized manner (Brink, 2006:67). The purpose of this chapter is to review literature about the impact of the National Curriculum Statement principle in the teaching of physical science in Grades 10-12 in Sekhukhune District. In order to achieve this purpose, the chapter describes an overview of education transformation in South Africa; the implementation of the National Curriculum Statement policy in South African schools; the teacher knowledge of the National Curriculum Statement and type of learner envisage by the National Curriculum Statement. The study further discusses integration and theoretical model informing the study.

2.2 An overview of education transformation in South Africa

After the transition for democracy in 1994, the new South African government was faced with the urgent need to dismantle the deeply flawed education system it had inherited. It was from this that the Ministry of Education produced a series of White Papers on Education, "White Paper Era". The White Paper on Education and Training articulated a vision of transformation driven by the need for education and training to empower people to participate effectively in all the processes and institutions of a democratic society and build a nation free of race, gender and any other form of discrimination (DoE 1995:17). The most

important of the White Paper on Education and Training of 1995 was the proposal for Outcomes-Based Education (OBE).

In 1998 Curriculum 2005 (C2005), driven by Outcomes-Based Education was introduced to South African schools in Grade 1 and Grade 7. This policy was introduced with the hope that it would be implemented in all Grades levels by the end of 2005. However, this did not happen. There were concerns raised with regard to the policy implementation. This period was followed by a phase of particular emphasis on service delivery (1997 to 2003) with a renewed focus on implementation by former President Thabo Mbeki. For example one of the concerns was that the implementation of C2005 would be sustained by teachers soon after taking office in 1999. In light of this statement, the then Minister of Education, Kader Asmal, appointed the Review Committee headed by Prof Linda Chisholm to review the policy.

The Ministerial Review Committee revealed the following challenges that impeded the effective implementation of C2005 (Chisholm; Volmink; Ndhlovu; et al, 2000:3):

- Inadequate orientation, training and development of teachers;
- Learning support materials that were variable in quality, often unavailable and not sufficiently used in classroom;
- Shortages of personnel and resources to implement and support C2005;
- Follow-up support was insufficient, teachers felt that officials did not value their work and that provincial Department of Education and school management, provided too little support; and
- Time frame was unmanageable and unrealistic.

Given the challenges experienced with C2005, in 2002, the Revised National Curriculum Statement (RNCS) and the National Curriculum Statement were developed for the General Education Training (GET) band and Further Education Training (FET) band respectively. Both the RNCS and NCS, like their predecessor, C2005, are still in the Outcomes-Based Education framework. The new curriculum, the NCS was being phased-in incrementally and systematically in the secondary schools Grades. First, the NCS had been introduced in Grade 10 in 2006, Grade 11 in 2007, and then Grade 12 in 2008.

According to Department of Education (DoE 2003: viii), the NCS represents a policy statement for learning and teaching in the South African secondary schools located in the FET band. The NCS replaces Report 550(2001/08) and aspires to redress the past divisions and to advance the social transformation agenda of the democratic government of South Africa (DoE 2003a:4). For this reason, the NCS aims to develop the full potential of each learner as a citizen of the democratic South African. Furthermore, it seeks to create a lifelong learner who is confident and independent, literate and numerate and multi-skilled, compassionate, with respect for the environment and the ability to participate in society as a critical and active citizen (Mosuwe & Vinjevold 2008:12).

The NCS envisaged the kind of learner who will be imbued with the values and act in the interests of a society based on respect for democracy, equality, human dignity, and social justice as promoted in the Constitution.

In addition, the NCS Grades R-12 aims to produce learners that are able to:

- Identify and solve problems and make decisions using critical and creative thinking;
- Work effectively as individual and with other members of a team;
- Organise and manage themselves and their activities responsibly and effectively;
- Collect, analyse, organise and critically evaluate information;
- Communicate effectively using visual, symbolic and/ or language skills in various modes;
- Use science and technology effectively and critically showing responsibility towards the environment and the health of others; and demonstrate an understanding of the world as asset of related systems by recognising that problem solving contexts do not exist in isolation. (Department of Education, 2011:4).

The Manifesto on Values, Education, and Democracy (Department of Education 2001:9-10) states the following about education and values:

...values and morality give meaning to our individual and social relationships. They are the common currencies that help make life more meaningful than might otherwise have been. An education system does not exist to simply serve a market, important as that may be economic growth and materials prosperity. Its primary purpose must be to enrich the individual and, by extension, the broader society.

Learners emerging from the FET band must (DoE 2003:5):

- Have access to, and succeed in , lifelong education and training of good quality;
- Demonstrate an ability to think logically and analytically, as well as holistically and laterally; and
- Be able to transfer skills from familiar to unfamiliar situations

2.3 Teachers envisaged by the National Curriculum Statement

Teachers are key contributors of the transformation of education in South Africa. They should be mediator of learning, interprets and designer of learning programmes and materials, leaders, administrators and manager, scholars, researchers and lifelong community members, assessors and specialists (DoE 2003:5). The NCS Grades10-12, physical science (general) (2003:5) visualizes teachers who are qualified, competent, dedicated, and caring and who will able to fulfil the various roles outlined in the Norms and Standards of Educators.

Through the introduction of the new curriculum, the Department of Education (1997) placed demands on teachers to adopt integrated teaching, to organize their teaching so that it promotes integration of one learning area with another. When a new policy the NCS is implemented in schools, both experienced and new teachers need to get used to it and be trained in the new system (DoE 2000a:15). Ramroop (2004:5) supports this statement with an argument that if people who need to be the driving force behind the change are not equipped with knowledge, skills and attitude to empower them to be a positive force of change, the any change attempt is sure to fizzle out. Van der Merwe (2002:32)

contends that teachers are more likely to respond positively to initiatives if they are given additional support during its planning and development stages.

Teachers should have the knowledge of how learners learn mathematics and science and how best to teach them. Effort should take now to direct the presentation of science and mathematics lessons away from traditional methods to a more learner-centred approach. Adler, Graven and Pounara (2006:6) write:

...teachers are expected to posse a broad general knowledge of matters unrelated to his or her subject and possibly also to be an expert in other subject areas.

After the new curriculum was introduced in South Africa, it became clear that teachers had to adopt new pedagogical approaches to teaching and learning.

Young (2009:28) states:

...the education of science teachers provides one of the most significant roadblocks to the implementations of high levels of the interdisciplinary teaching.

Implementation of the challenges lies with the education of the teacher. Teachers are expected to implement integrated teaching in their lesson.

However, Adler and Pournara (2000:6) point out:

There is a concern that teachers do not requisite knowledge, and are not well oriented to manage the demand of integrating across disciplines.

As was noted in 1999 during the implementation of C2005 “teachers” poor conceptual knowledge of the subject they are teaching is fundamental constraints on the quality of learning outcomes”...and “ teachers by and large support the intention of the new curriculum, but lack the knowledge resources to give effective use to these in classroom” (Vinjevoid & Taylor 1999:230). To prepare to teach mathematics and science, teachers need an in-depth understanding of mathematics and science (content) and teaching and learning (pedagogy and epistemology). They need an integrated knowledge of these different subjects, the overlap, and integration of these domains in mathematics and science.

Several researchers have explored pre- and in-service teacher perceptions on integrated mathematics and science teaching. Lehman (1994:56-64) shows that pre service teachers tend to express positive attitudes towards integration, whereas in-service teachers display reluctance, partly of their subject-oriented preparation.

Team teaching is still encouraged by many researchers as it enhances teaching and learning. Team teaching involves two or more educators whom their primary concern is the sharing of teaching experiences in the classroom, and co-generating dialoguing with each other. Jang (2006:177) writes:

They take collective responsibility for maximizing learning to teach, or becoming better at teaching, while providing enhanced opportunities for their students to learn.

The implementation of team teaching in the field of integrated learning is of utmost important. The key to this lies with the teachers, who required doing this actively; otherwise, educational reform will not achieve its goals. In team teaching, teachers may help one another with integration of learning outcomes within and across the subject. Social constructivist emphasize that the notion of inter-subjectivity is highly important. Conolly and Smith (2000:16-26) state:

No one person construes the stream of events in the same ways as others, as they interact with one another, they develop ideas that, because they are held in common, create a universe of discourse, a common frame of reference in which communication can take place.”

Team teaching gives teachers the opportunities to act on their ideas and reflect in and upon their actions.

The NCS encourages team teaching; teachers must plan a subject framework, learning programmes, work schedule and the pace. However, the integration within and across the discipline of teaching are often not implemented after all. Teachers must encourage learners to work together as they will thus acquire effective learning strategies and solve problems more successfully in mathematics and science.

To teach effectively, teachers need to have developed an integrated knowledge structure that incorporates knowledge about the subject matter, learners' pedagogy, curriculum and school. They need to have pedagogical content knowledge for teaching their subjects. Furner and Kumar (2007:186) write:

More and more teachers are coming to realize that one of the fundamental problems in school today is the separate or layer cakes approach of knowledge and skills.

Frykholm and Glasson (2005: 136) maintain that often learners cannot solve problems because they do not understand the context in which the problem is embedded. Learners must be able to identify the context and then analyse the problem; then it will be easier for them to get the solution. Integration is good; it enhances good learning and a teaching spirit among peer teachers and learners.

OBE encourages a learner-centred and activity based approach to education (DoE 2003:2). According to Gultig and Lubisi (1998:4), a learner-centred approach places the responsibility to learn on the shoulder of the learners instead of the teacher.

A learner-centred approach puts the learner first; all efforts are focused on the learner. DoE (1997(g):15) states:

The child is the primary point of departure based on the vision in which the child is given opportunities to grow and develop as an active citizen, contributing constructively to a democratic, non-racist, non-sexist and equitable society.

In contrast, Chisholm (2000:46) reports that this approach embraces the notion of active and visible learners constructing their own knowledge and an active but invisible teacher, whose role is to facilitate rather than direct learning. It emphasises a non-authoritarian classroom environment and the importance of activity and skills as a basis for knowing and knowledge.

2.4 The implementation of the National Curriculum Statement in South African schools

Mampuru (cf. Ndou 2008:34) perceives implementation as the most difficult phase of a change process as most shortcomings of the change may appear at this stage. This confirms Fullan's (1992:24) assertion that the early implementation of change is inevitably fraught with difficulties. The above views suggest that most of the problems related to curriculum change are noticeable during its implementation stage. On the same note Ramroop (2004:5) eludes that implementation of change impacts significantly on people and institutions and, if not administered correctly and sensitively, with a lot of skill and support, good ideas may become unachievable.

Prinsloo (2007:155-170) says that the main factors that hinder policy implementation in South African school are the lack of management capacity and the scarcity of resources. The NCS is a policy which serves as a resource to each teacher and thus offers three different pathways that learner can access the compulsory phase of schooling that is at the end of Grade 9. These pathways include: the general pathway offered by all schools which incorporates Grade 10 to 12; the General Vocational pathway offered by colleges that prepare learners for work that involves vocational skills; and trade; and the Occupational and Professional pathway which is offered mainly by industry-based providers, which learners can access via learnerships. This means that is learners can enter the workplace and learn the skills on the job.

The subjects in the NCS are arranged into learning fields, which serves as a home for cognate subjects, as well as integrating knowledge, skills and values. The boundaries between subjects are blurred as subjects are viewed as dynamic and responsive to the new knowledge. Subjects are also defined by Learning Outcomes, which are the statement of intended results of learning and teaching as well as assessment standards which function as criteria that collectively provide evidence of what a learner should know and be able to demonstrate in a particular Grade (DoE 2003:2).

The NCS also contains the Critical and Developmental Outcomes focus on values such as critical and creative thinking, collaboration, responsibility, knowledge organisation, communication, environmental awareness, and a holistic approach to problem solving. There are key principles and values that underpin the curriculum.

Physical science as one of the taught subjects supports the application of the nine NCS principle which applied to all subjects including mathematics and life sciences (DoE 2003:2-4). The nine principles are:

- **Social transformation**

Social transformation in education is aimed at ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all section of population (DoE 2003:2).

- **Outcome-Based Education**

Outcome-Based Education strives to enable all learners to reach their maximum learning potential by setting the Learning Outcome to be achieved by the end of education process. OBE encourages a learner-centered and activity-based approach to education (DoE 2003:2).

- **High knowledge and high skills**

High knowledge and skills sets up high expectations of what all South African learners can achieve. Social justice requires the empowerment of those sections of the population previously disempowered by the lack of knowledge and skills (DoE 2003:3).

- **Integration and applied competence**

Integration is achieved within and across subjects and fields of learning. The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence as defined in the National Qualifications Framework (NQF). Applied competence aims at integrating three discrete competences namely, practical, foundational and reflective competences (DoE 2003:3).

- **Progression**

Progression refers to the process of developing more advanced and complex knowledge and skills. The content and context of each Grade will also show progression from simple to complex (DoE 2003:3).

- **Articulation and portability**

Articulation refers to the relationship between qualifications in different NQF levels or bands in ways that promote access from one qualification to another. Portability refers to the extent to which parts of a qualification (subjects or unit standards) are transferable to another qualification in a different learning pathway of the same NQF band (DoE 2003:3).

- **Human rights, inclusivity, environmental and social justice**

The NCS Grades 10–12 (General) seeks to promote human rights, inclusivity, environmental and social justice. In particular, the NCS Grades 10 – 12 (General) are sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors. It acknowledges that all learners should be able to develop to their full potential provided they receive the necessary support (DoE 2003:4).

- **Valuing indigenous knowledge systems**

Indigenous knowledge systems in the South African context refer to a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years (DoE 2003:4).

- **Credibility, quality and efficiency**

Quality assurance is to be regulated by the requirements of the South African Qualifications Authority Act (Act 58 of 1995), the Education and Training Quality Assurance Regulations, and the General and Further Education and Training Quality Assurance Act (Act 58 of 2001) (DoE 2003:4).

Given the above information, the next section discusses the context of integration fully and illustrates how different subjects are integrated.

2.5 Integration as a principle of the National Curriculum Statement

Integration is a key design principle of the NCS that requires learners to use their own knowledge and skills from other subjects from different parts of the same subject, to carry out tasks and activities (www.sahistory.org.za/article/classroom). DoE (2003:3) explains that integration is achieved within and across subjects and field of learning.

In support to this explanation, Shawn and Bill (2006:23) state that integration is done to promote collaboration, to reflect the real world an existing approach to school subjects.

2.5.1 Integrating physical science with mathematics

Integrating science and mathematics in schools has become a central issue by organizations, such as the School Science and Mathematics Association (SSMA), the National Council of Teachers of Mathematics (NCTM), the

American Association for Advancement of Science (AAAS) and the National Research Council (NRC). According to Furner and Kumar (2007:186), these organisations strongly support the integration of mathematics and science, which is reflected in the recommended national standards documents such as the National Science Education standard (NRC,1996) and the NCTM standard (1989 and 2008) (Furner & Kumar 2007:186). Furner and Kumar (2007:186) recommend that the integration of mathematics and science encompasses a number of considerations, for example, teaching mathematics entirely as a part of science; mathematics as a language and tool for teaching science; or teaching science entirely as part of mathematics.

The expression “integration of science and mathematics” is used in different ways throughout the science and mathematics education community. Integration has been a commitment of the School Science and Mathematics Association. Given this commitment teachers need to understand different ways in which the term integration can be used and how it applies to the teaching of science and mathematics (Underhill 1994: 8).

According to Erdman (2004:146-148), “there are many school mathematics topics such as ‘vector’ that appears in mathematics textbooks as well as in science textbooks.” Erdman (2004) said that learners’ difficulties with vectors can be reduced if teachers devise outdoors activities to force learners to apply the concepts in terms of length and direction. On the same note the NCS states that the concept vectors is not discussed as a topic in the mathematics school curriculum but is dealt with in physical science curriculum (DoE 2003:5).

The key thought behind integrating science and mathematics is to develop relevancy and applicability of the discipline according to existing learner experiences (Miller, Devison & Mentheny 1995:226).Learners must see

mathematics and science as relevant component of their world. In other words, mathematics should no longer be seen as a discipline studied and applied for mathematics sake, but rather, because it will help make sense out of some part of our world. The 'doing' of mathematics and the 'doing' of science creates new ways for learners to look at the world in a way that develops depth rather than breath in mathematics (Miller et al 1995:227).

Miller et al (1995:227) further elaborate that science when integrated with mathematics provides the opportunity for learners to apply the discipline to real situations, situations that are relevant to the learner's world and present from the learner's own perspective. According to Miller et al (1995:227), there are five types of science and mathematics integration, namely: discipline specific integration; content; process; methodological; and thematic. These are further discussed in the next section.

- **Discipline specific integration**

This approach to integration involves an activity that includes two or more different branches of mathematics or science. For example, discipline specific integration might include activities involving algebra and geometry in mathematics and activities infusing biology, chemistry and physics in science.

- **Content specific integration**

Content specific integration involves choosing an existing curriculum objective from mathematics and one from science. It is content specific because it conforms to the previously developed curriculum, infusing the objectives from each discipline. For example, the study of simple machines in science, and proportions in mathematics where groups of learners are given meter sticks, a fulcrum and various metric weights. After balancing the lever, learners

determine the relationship between the masses of the weights and their distances from the fulcrum. In mathematics, the learners are working with proportion; in science, they are identifying the relationship between work and a simple machine called a lever.

- **Methodological integration**

The integration of methodology is rarely mentioned in current literature. In effect, 'good' science methodology is integrated in 'good' mathematics teaching. For example, mathematics should be developed under constructivist theory using science discovery and inquiry teaching techniques and building on prior knowledge (Miller et al 1995:229).

The Standard of the NCTM (1989:84) states that learners should be able to apply mathematics thinking and modeling to solve problems that arise in other disciplines. The methodological approach to the integration of scientific methods clearly focuses on experimental science. At present, a focus on integration of methodologies means that learners will investigate issues in both Science and mathematics, using related strategies such as inquiry, discover, and learning cycle.

- **Process Integration**

Another approach to integrating mathematics and Science is through the use of real-life activities in the classroom. By conducting experiments, collecting data, analyzing the data and reporting results, learners experience the process of Science and perform the needed mathematics (Miller et al 1995:229).

- **Thematic Integration**

The thematic approach begins with a theme which then becomes the medium with which all the discipline interacts. For, the theme could be oil spills: in mathematics one would be working with volume, surface area, and cost of cleanup; in Science, one would be working with density and the environmental aspects of oil spills (Miller et al 1995:229).

In light of the discussed types of integration, integration of science with mathematics can serve as a model for process integration within and across the curriculum.

The integration of science and mathematics is one way to improve teacher achievement in each discipline. Although teachers have not been trained to integrate within and across the disciplines, this needs to be implemented. Moreover, a continuum model, which has been structured and described to support trainers in facilitating teachers to integrate science and mathematics, is discussed in theory of model.

2.5.2 Integrating physical sciences with life science

Many science curriculum programmes stress how physics, chemistry, biology, and earth sciences are integrated and have common concepts such as dynamic equilibrium, energy, energy transformation, and conservation of energy. In support of this notion, Bill (2007:57) states, "Despite all the compartmentalization in science, you could argue that the different science disciplines have more in common than they have difference". For example, if the concept, 'energy transport' is introduced in Physics context, it is desirable to support its transferability to a biological and chemical context, and from all disciplinary contexts to daily life context. Another example is to tackle problems central to renewable energy. In this context learners have to use information

and skills from several subjects-technologies, earth science, physics and chemistry. These will show learners how physical science and chemical principles are relevant in the context of their own life.

A study conducted by Satchwell (2002:2) at the University of Illinois at Chicago (UIC) highlighted a course to help prospective elementary teacher to become qualified for and comfortable in teaching science in their classroom, in a way useful for future careers. Based on the findings of the study the cross-disciplinary nature of the course was intentional and explicit. This meant that each incorporated and integrated concepts drawn from earth and space science, environmental science, biology, chemistry and physics.

However, there are some challenges in integrating concepts within science; Satchwell (2002:2) explains the challenges as follows:

- The education of science teacher provides one of the most significant roadblocks of the implementation of high level of interdisciplinary teaching.
- Few teachers have had an opportunity to experience true interdisciplinary lessons themselves as students.
- There is understandable resistance to change.
- There are the pervasive external forces, such as lack of planning time and the pressure to perform with respect to pacing guides and end of course examinations.

All these challenges hinder the implementation of integration in teaching science. Integration methods of teaching science have an impact on the better

performance of learners and teachers. If this could be adopted in the teaching of science, it would uplift the standard of teaching science and learners in South Africa who would then be better able to compete internationally in science. Our learners would be able to participate in the Science Olympiad and achieve better results.

2.6 The continuum model of integration

Continuum model is the one in which a teacher or teachers explicitly assimilate from one discipline during instruction (Huntley 1998:321). Since the study is all about integration as a principle of the NCS, the theoretical model of integrating science and mathematics is used in the study. The continuum model of integration is employed to clarify the relationship between the mathematics and science concepts. Huntley (1998:321) further describes the continuum model of integration as the model that provides justification for curricula that include a range of activities from independent to balanced science and mathematics teaching. It also illustrates the complexity of the relationship between mathematics and science that contributes to the great difficulty in characterizing this relationship (Underhill 1995:1).

Lonning and Defranco (1997) designed a continuum model of integration that would assist teachers to clarify the relationship between concepts. Lonning and DeFranco (1997:228) suggest that this continuum is particularly useful in curriculum development as the continuum gives the teacher an excellent model for addressing the question: how much integration and when? This continuum of Integration of mathematics and science concepts or activities also focuses on the issue that different forms and degrees of integration are needed for successful delivery of the many types of concepts inherent in mathematics and science.

In addition to Lonning and DeFranco's (1997) model is Huntley's (1998:320) model which clarifies the ill-defined nature of phase-integrated mathematics and science education. The Continuum of Integrated Curriculum, according to Huntley (1998:321), is a model for an integrated curriculum consisting of continuous categories that present the different possibilities regarding the extent of interaction between content disciplines. In this type curriculum teachers purposely plan for the use of more than one discipline to teach concepts in order to provide learners the opportunities to make meaningful connections between the concepts. Huntley (1998:322) establishes five continuous categories that depict the different way in which science and mathematics are interrelated. These five categories are also situated from left to right on the continuum and are entitled: mathematics for the Sake of mathematics (M); Mathematics with Science (Ms), Mathematics and Science (MS); Science with Mathematics (Sm) and Science for the Sake of Science(S). A simple representation of this continuum, with a capital letter denoting the primary emphasis and the lower case letter representing the secondary focus, is illustrated in Table 2.1. A brief description of the continuum is given as follows: At one end of the continuum would be mathematics activities not involving science. At the other end of the continuum would be science activities not involving mathematics. At the center of the continuum are those activities meeting the curricular objectives for both science and mathematics. Such activities can be referred to as balanced integrated activities.

The model emphasises the importance of a team approach to theme selection and activity development. It has been the author's experience that through collaboration and dialogue, more powerful themes and activities have been developed (Lonning & DeFranco 1998:317). It is believed that the choice and adoption of a continuum model in this study will support collaboration in the teaching of physical science, mathematics and life sciences concepts. In would

mean that physical science teachers, mathematics teachers and life science teachers will sit together in their planning, identifying common concepts that can be taught the same in both subjects. These will reinforce the concepts in both subjects and learners understood it better. Learners will acquire more knowledge on common concepts taught by different teachers.

Although the interaction between mathematics and science was first recognized a long time ago, teachers cannot reflect this close relationship under current curriculum of NCS. One of the reasons for this disability is that integration within and across the subjects is dominant. The continuum model takes this fact into consideration and offers the teachers a variety of integration options. Teachers who use the continuum model, which can be regarded as simple versions of an integrated curriculum, may improve their self-efficacy and achieve total integration over a time.

Table 2.1: Math and science linear integration continuum (Adapted from Berlin 1994:84)

M	Ms	MS	Sm	S
Math	Math – Science Context	Math and Science	Science – Applied Math	Science

In this table (Table 2.1) either end of the continuum represents the pure mathematics or the pure science whereby each discipline is preserved as a separate entity.

The beauty and abstractness of mathematics is explored without an obligatory application or use and science phenomena are investigated without need for

quantification. The next category (Ms) that focuses upon mathematics utilizes the science context as a way to enhance learners use and understanding of mathematics. Similarly, the category(Sm) that focuses upon science applied the tools of mathematics to quantify scientific patterns and relationship (Berlin 1998:499-512).

Rather than using a linear integration continuum, Berlin (2010:85) proposes a more complex approach to this process of designing an integrated mathematics and Science learning environment (see Figure 1.1)

Figure 2.1: Science and mathematics integration sequence (adapted from Huntley 1998)

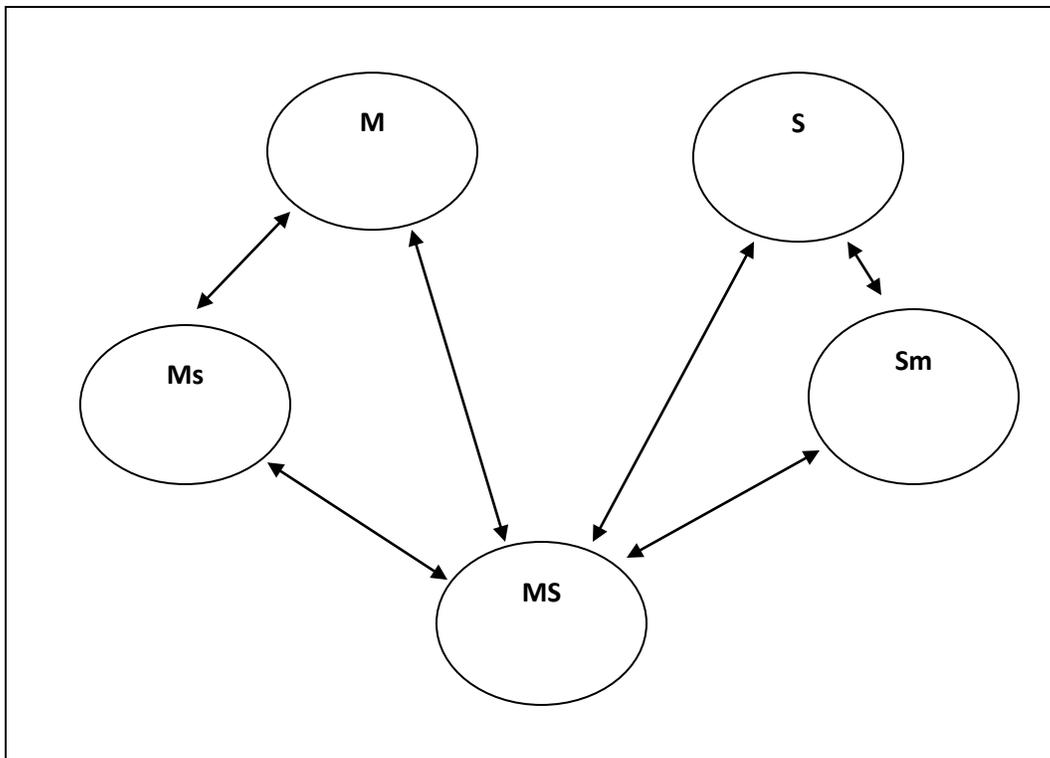


Figure 2.1 depicts a multi-directional sequence model in contrast to the often cited linear integration continuum model.

It is important that both the science teacher and the mathematics teacher work together to decide upon the appropriate sequence in the integrated learning environment so that the perspectives of both disciplines are fairly represented in a coherent and cohesive manner (Berlin 2010:85)

In support of the above-mentioned views, Frykholm and Meyer (2002:504) contend that when scientific phenomena are pursued authentically, they can open the door for enriching exploration of mathematics concepts that otherwise would remain as isolated topic. In the same vein, Basista and Matthews (2002:359) echo these beliefs:

“Science provides rich context and concrete phenomena demonstrating mathematics and mathematical patterns and relationships. Mathematics provides the language and tools necessary for deeper analysis of science concepts and application.”

Drake (1991:20) uses the terms multidisciplinary, interdisciplinary, and transdisciplinary to describe possible approaches to integration along a continuum. These approaches begin with the idea of “dissolving the boundaries” between, between the deliveries of content areas. The multidisciplinary approach involves teachers finding the appropriate place to introduce their particular subject area into a topic being taught by team of teachers at the same time during a school year. This approach is content based and allows each discipline to retain its own integrity (Kysilka 1998:23.).

Connections exist between study of a topic studied and not because of a forced attempt to relate different discipline (Drake 1991:20). Finally, the transdisciplinary approach emphasizes a process where the needs and interest

of learners determine the knowledge studied and explored as opposed to a mandated set of curriculum objectives; the transdisciplinary level is “life-context based” (Sands & Drake 1996:71).

Kellough (1996:3) offers an integration continuum model similar to the one proposed by Jacobs. Jacob (1989b:13-24) describes the level of the integrated continuum model as follows: The Discipline Base option is reflected in traditional teaching practice of today where subjects are taught in separate blocks during the school day. In the Parallel Discipline level, teachers of different content areas plan the sequence of their lesson to correspond to each other’s lesson. The Complementary Discipline units’ option brings together certain disciplines that are related to one another in a formal unit to study a topic, for example, science and mathematics or content areas under the heading of humanities. An interdisciplinary unit purposefully utilizes the full range of the discipline in school to examine a problem. The integrated-Day and Complete Program are especially based upon problems emerging from the learner’s world. In these last two, Integrated-Day and Complete, there is no guarantee that an established content objective and the base core curriculum requirements will be met. Jacob (1989c:54) asserts that the interdisciplinary units option calls for a plan to be established by the teacher to clarify the unit of the study to ensure success.

By integrating all the subject areas available within the school, as this option advocates, learners are provided opportunities to become conscious of the relationship among disciplines as they investigate subject matter. In addition to the organization of content areas, Kellough’s integration continuum model specifically addresses the levels of collaboration between teachers of different disciplines and the role learners play in the planning and delivery of classroom activities.

In Level 1 the least integrated side of the continuum, subjects are taught separately by one teacher with low input from learner decisions. Level 2: involves a lone teacher or the team-teaching of a subject-specific thematic unit with minimal learner input. Level 3: 4 and 5, all involve solo teacher planning or the collaboration of team teaching. Learners input increases from higher to very higher as Level 5 is reached. Level 3 is called the Multidisciplinary Thematic Approach; Level 4 is called the Interdisciplinary Thematic Approach and Level 5, the Integrated Thematic Approach.

The Multidisciplinary Thematic Approach involves teachers working separately yet under a common theme to present a topic at the same time during school year. The Interdisciplinary Thematic Approach engages many disciplines to study a topic as “discipline boundaries begins to disappear” (Kellough 1996:4). The teacher or team of teachers utilizes many content areas to examine a topic with a great amount of input from the learners in what problem will be studied and how the investigation of the problem will take place. The Integrated Thematic Approach involves a grander scale than the previous level. Here learners and teachers and teams of teachers collaborate not only across disciplines but also across Grade levels and other programmes offered in the school to study a topic.

It could be suggested that teachers training institution may employ the continuum model in order to teach student teachers how to integrate physical science and mathematics as well as related content, skills, affective characteristics, teaching methods and approaches. Training teachers using this model may contribute to the common usage of integrated scientific and mathematical curriculum in NCS. This will yield better results of physical science in our country.

2.7 Conclusion

It has transpired from the preceding review of literature that the NCS has a number of features. The overview of education transformation in South Africa; the implementation of the NCS policy in South African schools; integration within and across the subjects and theoretical model informing this study were reviewed. In the next chapter the research methodology of the study will be detailed.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this chapter is to outline the research methods and design used in the study. To achieve this purpose, the chapter describes the specific research paradigm and outlines a research methods, design and measures to ensure trustworthiness. The chapter further discusses the ethical measures considered in the study.

3.2 Research paradigm

A paradigm is defined as a fundamental orientation perspective of world views which is often not questioned and is subject to empirical test (De Vos2006:262). In contrast, Bogdan (2007:24) describes a paradigm as a loose collection of logically related assumptions concepts or proposition that orient thinking and research. Based on the above definitions, Burrell and Morgan (1997:85.) identify four sets of assumptions: ontology, epistemology, assumption and methodology. These sets of assumptions are described in the following section.

3.2.1 Ontology

Ontology is an assumption which concerns the very nature or essence of the social phenomena being investigated.

The assumptions hold that object of thoughts are merely words and that there is no independently accessible thing constituting the meaning of word (Burell & Morgan 1997:85).

3.2.2 Epistemology

Epistemological assumption concerns the very bases of knowledge, its nature and forms, how it can be acquired and how is communicated to other human beings. It determines extreme positions on issues of whether knowledge is something which has to be personally experienced (Burell & Morgan 1997:85)

3.2.3 Assumption

Assumption concerns human nature and, in particular, the relationship between human beings and their environment. Human beings respond mechanically to their environment and human beings are initiators of their own action (Burell & Morgan 1997: 85.).

3.2.4 Methodology

A methodological assumption has nomothetic and idiographic dimensions. Nomothetic is an approach characterized by procedures and methods designed to discover general principles, while idiographic is aimed at understanding individual behavior (Burell & Morgan 1997:85.).

In light of these four assumptions, epistemology was used in this study to investigate the impact of integration as the principle of NCS in the teaching of physical science in Grades 10-12.

3.3 Research method and design

It is important to have a strategic plan of how to proceed in the study. Planning what one is going to do and how to do it gives a route one has to follow. This study gives a clear description on how the research design and methods were used.

The intention of a research method and design is to provide a set of issues that need to be addressed in practice so that an area of research interest can become practical, feasible and capable of being undertaken. Research might be operational that is, how general set of research aim and purpose can be translated into a practical, researchable topic (Cohen & Manion 2007:73).

3.3.1 Research method

There are two types of research approaches, namely qualitative and quantitative approaches. Qualitative research has its roots in the social sciences and is more concerned with understanding why people behave as they do their knowledge, attitudes, beliefs and fears (Merriam 1988:18). Quantitative research on the other side is concerned with counting and measuring things, producing, in particular, estimates of averages and differences between groups (Merriam 1988:18).

To make a distinction between the two methods, Merriam (1988:18) highlights the characteristics of qualitative and quantitative approaches (see Table 3.1).

Table 3.1: Characteristics of Qualitative and Quantitative research (Adapted from Merriam 1988:18)

Point of comparisons	Qualitative Research	Quantitative Research
Focus of research	Quality (nature, essence)	Quantity (how much, how many)
Philosophical roots	Phenomenology, symbolic interaction	Positivism, logical empiricism
Associated phrases	Fieldwork, ethnographic, naturalistic, grounded, subjective	Experimental, empirical, statistical
Goal of investigation	Understanding, description, discovery, hypothesis generating	Prediction, control, descriptions, confirmation, hypothesis testing

Design characteristics	Flexible, evolving, emergent	Predetermined, structured
Setting	Natural, familiar	Unfamiliar, artificial
Sample	Small, non-random, theoretical	Large, random. Representative
Data collection	Researcher has primary instrument, interviews and observations	Inanimate instruments(scale, tests, surveys, questionnaire, computer)
Mode of analysis	Inductive (by researcher)	Deductive (by statistical methods)
Findings	Comprehensive, holistic, expensive	Precise, narrow, reductionist

Based on the given characteristics and the purpose of this study, a qualitative research method was selected for the study. Qualitative research as explained by Leedy (2005:133) is the approach that focuses on phenomena that occur in the natural settings (i.e., in the 'real world') and also involves studying those phenomena in all complexity. Leedy (2005:133) further adds that the researcher is an instrument in the same way as a rating scale or intelligence test instrument.

Creswell (1998:74) states that all qualitative researchers approach their studies with a certain paradigm or world-view, a basic set of beliefs or assumptions that guides their enquiries. For this reason epistemology assumption is selected for this study (refer to paragraph 3.2). Based on the mentioned characteristics of qualitative research, the researcher understood participants' interpretations on integration as a concept as well as a principle of NCS. To be specific, Bogdan (2007:40-45) explains that qualitative researchers understand human behavior as complex search for cause and prediction as undermining their ability to grasp the basic interpretive nature of human behavior and human experience. They seek to grasp the process by which people construct meaning and to describe what those meanings are.

3.3.2 Research design

There are many definitions of research design. Mouton (2001:55) defines a research design as a plan or blueprint of how one intends conducting the research. Huysamen (1993:10) offers a closely related definition of design as a plan or blueprint according to which data are collected to investigate the research hypothesis or question in the most economical manner. In contrast Bless and Higson-Smith (1995:63) define research design as "a specification of the most adequate operation to be performed in order to test a specific hypothesis under given condition". These definitions cause confusion to the reader.

However, Rubin and Babbie (2001:107) address the concept of research design and state that the term research design has two connotations: The first connotation refers to an alternative logical arrangement from which one or more can be selected; and the second connotation deals with the act of designing the study in its broadest sense. For the purpose of this study, these definitions refer to a way or procedures with directions to be followed in conducting research.

This study follows a phenomenological design to understand the participants' perception in understanding the principle of integration as applied in the curriculum. The aim of phenomenology is the return of the concrete, captured by the slogan 'Back to the things themselves' (Eagleton 1983:56; Kruger 1988:28, Moustakas, 1994:26). According to Welman and Kruger (1999:189), "the phenomenologists are concerned with understanding social and psychological phenomena from the perspectives of people involved".

Phenomenology was used to guide this study. In-depth phenomenological interviews were used in order to understand the NCS policy and its principle of integration in teaching physical science. Rice and Eezy (1999:160) emphasize the usefulness and importance of using phenomenology in order to understand an experience from the perspectives of the research participants. The reason for using phenomenology research was to describe fully the impact of the National Curriculum Statement in teaching physical science. Meanwhile Babbie and Mouton (2001:33) explain that phenomenology enables the researcher to be close to the respondents and view the world from their perspective.

According to Bogdan (2007:25) the phenomenologist believes that multiple ways of interpreting experience are available to each of us through interaction with others. These authors also believe that there are people out there in the world who say and do things that qualitative researches can record and they strive to have their writing consistent with the data they collect. Based on this information, phenomenology design helped in the collection of data from the participants by listening what they say and by also looking at their behavior, that is, how they do things.

3.3.2.1 Data collection techniques

For the purpose of this study a qualitative approach is selected. De Vos (1998:253) states that a qualitative research approach requires that the data collected is rich in description of the phenomenon under study. For the purpose of this study, in-depth participant observation, semi-structured and focus group interviews were used to collect rich and descriptive data.

To make this possible, the researcher of this study interacted with different participants in order to listen to what they say and looking at how they do things (Bodgan 2007:25)

- **Participant observation**

De Vos (2006:275) describes participant observation as a qualitative research procedure that studies the natural and everyday set-up in a particular situation. The researcher maintained a balance between being an insider as well as being an outsider. Participant observation practice helped the researcher to become part of the lives and daily routine of respondents.

Researcher was part of the situation and even contributes to it by listening, seeing, observing, inquiring and writing up the notes. Researcher became part of the lives and daily routine of respondent. In the meantime was involved in daily routine by collecting data and interpret the data.

According to Graziano and Raulin (2000:131), a researcher becomes part of the situation being observed and even contributes to it. As participant observation focuses on explaining the natural occurrence of phenomenon, therefore the results may be of a high standard. Eight schools were visited and lessons were observed for a period of one hour.

- **Interviews**

De Vos (2006:287) indicates that in data collection, interviews are emphasized as the richest for qualitative approach. Conversation is the basic mode of human interactions. Through conversation we get to know other people, learn about their experiences, feelings, attitudes and the world they live. For the purpose of this study, semi-structured and focus group interviews were selected as one of strategies for collecting data.

- *Semi-structured interviews*

Morse (1991:189) defines semi-structured interviews as those organized around areas of particular interest, while still allowing considerable flexibility in scope and depth. Semi-structured interviews were adopted in this study to allow the researcher not only to obtain authentic data but also to develop a good relationship with the participants. The purpose of the interview was to investigate the impact of integration as the principle of the NCS in the teaching

of physical science in Grades 10-12. The researcher wanted to discover the new aspects of integration by exploring in detail the explanations supplied by the participants.

This is based on the ideas of Bless and Higson-Smith (2006:119) who state:

Wealth and quality of data gathering are strongly dependent on the skill of the interviewer and the confidence inspired in the respondents.

Leedy (2005:184) maintains that the semi-structured interview is where the researcher may follow the standard question with one or more individually tailored questions to get clarification of a person's reasoning. However, Warsal (2009:46) argues:

Semi-structured interviewing is appropriate because participants are able to express themselves freely without the interviewer controlling the discussion as well as help to develop connectedness with the interviewees.

Semi-structured interviews were organized in such a way that the participants, while answering specific questions, felt free to argue during the conversation with what they considered valid. Eight teachers from each of the selected schools participated in the semi-structured interviews. The interviews were conducted at their work place after school hours at about 15h00. The researcher made appointments with the participating schools in order to visit them. During this meeting, the researcher introduced and described the research topic and the process.

- *Focus group interviews*

De Vos (2002:307) describes the focus group interviews as one that promotes self-disclosure among participants. According to De Vos (2002:307), the focus group interviews draws on three fundamental strengths that are shared by all qualitative methods: exploration and discovery; context and depth; and interpretation. De Vos (2002:307) further states that the focus group interviews creates a process of sharing and comparing among the participants and it is also a powerful means of exposing reality and of investigating complex behavior. Based on this notion, the focus group interviews are concerned about encouraging people to share different points of view.

In the same vein, Kvale and Brinkmanne (2009:150) describes the focus group interviews as characterized by non-directive interviewing where the prime concern is to encourage a variety of viewpoints on the topic within the focus for the group. In contrast, Morgan (1997:6) describes the focus group interviews as a research technique that collects data through group interaction on a topic determined by the researcher. Morgan and Krueger (1998:33) maintain that the most common abuse by far of the label 'focus group interviews' occurs when it is applied to things other than research. Morgan (1997:2) comes with three basic uses for focus groups interview:

- They are used as a self-contained method in studies in which they serve as the principal source of data.
- They are used as a supplementary source of data in studies that rely on some other primary method.

- They are used in multi-method studies that combine two or more means of gathering data in which no one primary method determines the use of others.

A group of teachers from the selected schools participated in the focus group interviews.

A topic of focus was outlined whereby participants were given an opportunity to discuss and their responses were listened to. The researcher's task in this regard was to create a permissive atmosphere for the expression of personal and conflicting viewpoints on the topic in focus. The aim was not to reach consensus about or a solution to the issues discussed, but to bring forth different viewpoints on a topic under discussion.

3.3.2.2 Data analysis

Marshall and Rossman (1999:150) define qualitative data analysis as a search for general statements and about relationship categories of data; it builds grounded theory. According to Patton (2002:432), qualitative analysis transforms data into findings.

This involves reducing the volume of raw information, sifting significance from trivia, identifying significant patterns and constructing a framework for communicating the essence of what the data reveal. In addition, De Vos (2006:333) defines data analysis as a process of bringing order, structure and meaning to the mass of collected data. Based on the description of data analysis and for the purpose of this study, Marshall and Rossman's (1999:152-159) guidelines were followed. Marshall and Rossman (1999:152-159) highlighted the following guidelines of data analysis:

- Planning for recording data
- Data collection and preliminary analyses
- Managing or organizing of data
- Reading and writing memos
- Generating categories, themes and patterns
- Coding the data testing the emergent understanding
- Searching for alternative explanations
- Representing, visualizing (i.e., writing the report).

- **Planning for recording data**

The researcher planned a system to ease the retrieval for analysis. This included color coding of notes in order to keep track dates, names, titles, attendance at events, description of settings, defining categories for data analysis and planning for further data collection especially for writing the final product of the research.

- **Data collection and preliminary analysis (the two fold approach)**

De Vos (2006:335) states that analysis in qualitative inquiry necessitates a twofold approach, which includes data analysis at the research site during data collection and data analysis from the site, following a period data was collected. In the same tone, Erlandson, Harris, Skipper and Allen (1993:113) state that the second approach is conducted between site visit prior to, as well as after completion of data collected. Data analysis frequently necessitates revisions in data collection procedures and strategies. This means that data collection and analysis go hand in hand in order to build a coherent interpretation of the data.

In this study the information collected helped the researcher to work with the same person other than everybody at the school. After the interviews, the researcher transcribed the collected data.

- **Managing (organizing) data**

Transcribing interview or notes is another point of transition between data collection and data analysis as part of data management and preparation. For the purpose of this study the researcher organized the data into file folders.

Creswell (1992:143) highlights that the researcher converts their files to appropriate text units, for example, a word, a sentence, an entire story, for analysis either by hand or computer. The data gathered were then put in different labeled files. By so doing interview transcription provides an opportunity to get immersed in data and this experience usually generates emergent insight.

Patton (2002:441) advises that putting one master copy away somewhere secure for safekeeping. He (2002:442) likes to have one hard copy handy throughout the analysis, one copy for writing on and one or more copy for cutting and pasting. Based on this guideline the researcher in this study put one master copy away in a safe place for reference if mistakes occurred during the analysis.

- **Reading and writing memos**

Marshall and Rossman (1999:153) says that reading, reading, reading once more through the data forces the researcher to become familiar with the data in intimate ways. In this study, reading the data for several times helped the researcher to clean up what seemed overwhelming and unmanageable.

- **Generating categories, themes and patterns**

This guideline forms the heart of qualitative data analysis. According to Marshall and Rossman (1999:154), this is the most difficult, complex, ambiguous, creative and enjoyable phase. De Vos (2006:338) states that the process of category generation involves nothing about regularities in the setting. This means that they should be internally consistent but distinct from one another. Based on this idea, the researcher in this study identified the salient grounded categories of meaning held by participants in the settings

- **Coding the data**

According to Marshall and Rossman (1999:157), coding data is the formal representation of analytic thinking. The researcher in this study applied some coding schemes to those categories and themes. Abbreviation of keywords was also used as a form of codes.

- **To test the emergent understanding**

The data were evaluated for their usefulness and centrality. Research determines how useful the data are in illuminating the question being explored and how central they are to the story that is unfolding about the social phenomenon being studied. By so doing the researcher challenges the understanding, searches for negative instances of the patterns and incorporates these into larger constructs, as necessary.

- **Searching for alternative explanations**

Marshall and Rossman (1999:157) explain that alternative explanation always exists; the researcher must search for identify and describe them, and then demonstrate why the explanation offered is the most plausible of all. After the researcher discovered categories and patterns in the data, she engaged in critically challenging the very pattern that seemed so apparent. The researcher searched for plausible explanations of these data and the linkages among them.

- **Writing the report**

Bogdan (2007: 159) maintains that data analysis is the process of systematically searching and arranging the interview transcripts and other materials accumulated to enable you to come up with findings. At this stage is where the researcher presents the data, a packaging of what was found in the text data analysis.

3.4. Research population and sampling

3.4.1 Research population

The research population is the entire set of individual that meets the sample criteria of the study (Burns & Grove 2003:233). Physical science teachers who teach grades 10-12 were selected as a target population for the study. Although grades 10-12 can involve more than one teacher, for the purpose of this study only one teacher from each of the selected schools participated in the study.

3.4.2 Research sample

Purposive sampling was utilized to select the research sample. A sample is a fraction of the whole population selected by the researcher to participate in the study (Brink, 2006:124). Research sampling involves the selection of the sample that can be a group of people, events, behaviors or elements (Burns & Grove, 2003:233). According to Burns and George (2003:255), a purposive sampling method involves conscious selection of certain participant to gain insight or obtained an in depth understanding of complex experiences or events.

The advantage of the purposive sample technique was that the technique allowed the researcher to select participants with different characteristics to gain rich data. It was required that participant need to be having teaching experiences. The researcher found it was necessary to consciously select participant with different credentials such as teachers, Head of The Department and Deputy Principal in order to obtain in depth rich insight from different perspectives. Four teachers, three Heads of Department of Science and deputy principal were selected in the study.

3.5 Measures to ensure trustworthiness

De Vos (2005:346) argues that the verifiability of qualitative research is accurately assessed according to its trustworthiness. To ensure valid results, Guba's (1981) model of trustworthiness of qualitative research was used (in Krefting 1991:215-222). This model identifies four criterion of trustworthiness, namely truth-value; applicability, consistency and neutrality.

3.5.1 Truth-value

Krefting (1991:215) says truth-value is concerned with the ability of the researcher to establish confidence in truth of the findings for the respondents, the setting in which the investigation was conducted and the study's design. In qualitative research, truth-value is termed credibility. Truth-value is the most important criterion for the evaluation of qualitative research. In the study, truth-value was obtained by applying the strategy of credibility and triangulation of methods such as participant observation, focus group interviews and semi-structured interviews.

Triangulation is a method used by qualitative researchers to check and establish validity in the studies. Triangulation of methods (participant observation; semi-structured and focus group interviews) was employed in the study.

Mathison (1988:13) elaborates this by saying:

Triangulation has raised an important methodological issue in naturalistic and qualitative approach to evaluate [in order to] control bias and establish valid propositions because traditional scientific techniques are incompatible with this alternate epistemology.

Patton (2001:247) advocates the use of triangulation by stating “triangulation strengthens a study by combining methods”. In any qualitative research the aim is to “engage in research that probes the deeper understanding rather than examining surface features”. Streubert and Carpenter (1999:300) state that triangulation may be chosen to ensure completeness of the findings or to confirm the findings. Completeness of the findings provides breadth and depth of the research offering, the researcher a more accurate picture of the phenomenon. Krefting (1999:219) describes triangulation as a powerful strategy for improving the quality of the research, particularly credibility.

3.5.2 Applicability

This is second aspect of trustworthiness. Krefting (1991:216) said in qualitative studies, applicability is not that important because the main aim is to describe a particular phenomenon or experience, not to generalize to a larger population. Transferability is the strategy against which applicability of qualitative data can be assessed.

Lincoln and Guba (1985:81) state that transferability is more of the responsibility of the person wanting to transfer the research findings to another situation or group of people than the researcher of the original study. The dense description of the research methodology, literature control and quotations taken from transcripts were used.

3.5.3 Consistency

Consistency is the third criterion to ensure trustworthiness. Babbie and Mouton (2001:278) point out that the research must show evidence or proof that repeating it with the same or similar participants in the same context would produce the same results. The key to qualitative research studies is to learn from participants, not control them (Krefting 1991:216). In qualitative research, consistency is defined in terms of dependability.

3.5.4 Neutrality

The fourth aspect to ensure trustworthiness is neutrality. Krefting (1999:216) refers neutrality as to the extent that the findings are a function solely of the participants and conditions of the research and not of any biases, motivations and perspectives. In qualitative research neutrality is defined in terms of confirmability. Krefting further describe confirmability as strategy that involves an external auditor attempting to follow through the natural history or progression of events in an investigation to understand how and why decisions were made. In light of the above descriptions and for the purpose of this study, truth value was found to be more relevant in measuring the trustworthiness of the study.

3.6 Ethical considerations

Bless and Higson-Smith (2006:140) said that research ethics place an emphasis on the human and sensitive treatment of research participants who may be placed at a varying degree of risk by research procedures. The researcher ensured that her research is ethically conducted. Ethical consideration in research are always evolving and changing. The researcher made sure that the study met the highest ethical standards of the research. The following measures were considered in this study:

3.6.1 Informed consent

Babbie (2004:512) defines informed consent as a norm in which subjects base their voluntary participation in research project on a full understanding of the possible risks involved. It is formatted as a form that needs to be filled. Informed consent is also called voluntary participation. Informed consent ensures the full knowledge and cooperation of subjects, while also resolving or at least relieving, any possible tension, aggression, resistance or insecurity of the subjects (Babbie 2001:470; Thomas & Smith 2003:21).

To follow ethics in this study, the researcher requested participants to sign the consent forms. The researcher also explained the purpose of the study and made it explicit that participants indeed understood what had been explained to them about the topic of the research. Participants were promised that the data provided would at all times be kept under secure conditions.

Their names will always be anonymous, and at any time in the processes of the research, if they decide for any reason that they would like to withdraw their participation; this will not prejudice their receiving services.

3.6.2 Confidentiality

Sieber (1982:145) defines privacy as “that which normally is not intended for others to observe or analyze”. Confidentiality and privacy are synonymous. Singleton et al. (1988:454) further explain that “the right to privacy is the individual’s right to decide when, where, to whom and to what extent his or her attitudes, beliefs and behavior will be revealed”. Therefore, information provided by participants should be protected and made unavailable to anyone other than the researcher.

The researcher in this study promised to keep the nature and quality of participants’ performance strictly confidential. The researcher gave each participant a code number and then labeled any written documents with that number rather than with person’s name. In the study the researcher considered the research ethics as important. It helps to prevent research abuses and assist researchers in understanding their responsibilities as ethical scholars.

3.7 Conclusion

This chapter has covered important ground and returned to questions about research method and design. A qualitative research approach was used so as to understand a basic set of beliefs or assumptions that guide the inquiries or investigation of the impact of integration as a principle of the NCS on teaching physical science in Grades 10-12. Data collection strategies as well as data analysis were discussed. The research population and sample was also discussed. Lastly, the ethical consideration was discussed together with its informed consent and confidentiality. The next chapter discusses the analysis and interpretation of results.

CHAPTER 4: ANALYSIS AND INTERPRETATION OF PARTICIPANT OBSERVATIONS, SEMI-STRUCTURED AND FOCUS GROUP INTERVIEWS

4.1 Introduction

In this chapter the analysis and interpretation of data are discussed. Qualitative data analysis was used to analyze and interpret data collected through the use of participant observations, semi-structured and focus group interviews.

4.2 Results of participant observations.

Participant observations as one of the data collection techniques were used in collecting the data for this study. The purpose of using participant observation was to investigate the impact of integration as a principle of the NCS in the teaching of physical sciences in Grades 10-12. In analyzing data collected from the participant observations, the following themes transpired: lesson presentation and classroom organization. Each of these themes is outlined in the following sections.

4.2.1 Lesson presentation

The findings with regard to the lesson presentation revealed that there was no evidence of systematic lesson plan, integration of learning outcomes within and across the subjects and feedback given to learners. Lesson presentation is possibly the most important aspect of teaching practice. During a lesson all theoretical aspects of the discipline of education have to be integrated as a

whole. The findings are further discussed under the lesson plan as well as the learner involvement.

4.2.1.1 Lesson plan

A lesson plan is a written exposition of the teacher's plan for a lesson. It outlines what the teacher wants to achieve with learners in a given period; how he or she wishes to do this (teaching method); how he or she plans to involve the learners and which teaching and learning media he proposes to use in the lesson. According to Fourie (1991: 219, 229), a lesson plan is a structured activity in which all participants are actively involved. Fourie (1991: 219, 229) further explains that a lesson plan indicates what has already been done and also in what direction the learners should be guided as well as what work is to be taken up immediately.

Planning a lesson is so important that even the teacher with many years of experience should not enter a classroom without first having designed a plan of action for specific class. A good lesson plan requires careful consideration of all written out aspects of the lesson. In that way teachers will be able to identify the aspects of a learning outcome which are not achieved and therefore, come with some immediate intervention strategies. During participant observations, it was discovered that most of the teachers do not make efforts in planning their lessons before doing the presentation. This would mean that there is no systematic lesson planned which would be followed by the Grade 10 – 12 physical science teachers. In this case, participants were found to be using scribblers in preparing their lessons. It is a prerequisite that lessons should be planned and structured in such a way that the learners become motivated and gain knowledge that will enhance them to think and work accordingly.

The other finding indicates no evidence of integration of learning outcomes and assessment standards within and across the subjects. The NCS policy documents emphasize the promotion of an integrated learning of theory, practice and reflection (DoE 2003:3). This implies that participants do not use guidelines in the textbooks that are samples of lesson plans. The NCS textbooks have some samples of lesson plans which teachers may follow in teaching their subjects. These plans also guide teachers on how to integrate learning outcomes and assessment standards within and across the subjects. Integration helps teachers to know and understand what they intend to achieve at the end of a lesson and grade. It is imperative in this regard that teachers acquire knowledge and understanding of the learning outcomes and assessment standards in each subject in order to integrate them accordingly .If teachers are not well informed about the knowledge that learners have to acquire at the end of each lesson, this would impede good teaching and learning. This may impact negatively on the lesson taught as well as the learner performance; based on the fact that nothing was grasped during that lesson period.

Participants seemed not to consult the subject policy document. This might be due to ignorance or not being able to interpret what is written in the subject policy document. This is an indication that during the introduction of the NCS policy, proper training of teachers on how to interpret and use the NCS policy as well as the assessment standards was not well outlined. Even the practicality of using some principle was not well shown or demonstrated by facilitators(trainers). This has opened a bigger gap in implementing the NCS in the teaching and learning of physical sciences.

Participants seem to be working in silos when preparing for their lessons. This shows lack of cooperation and team work. To achieve the set goals and outcomes of the lesson, there must be cooperation between teachers with regard to the lesson preparation. This finding is in line with Baron's (2003:495) definition. He defines cooperation as working together with others to obtain shared goals which is also a common aspect of social life.

Working cooperatively will help teachers who have perspectives, backgrounds and areas of expertise somehow different from others to collaborate and share a common understanding. The emphasis in this regard is placed on how to learn and less on the learning content.

Each individual has to develop a sense of responsibility and has to realize that the survival of the group depends on the performance of each group member. Based on the cooperative learning theory, teachers can work as clusters to help one another to implement the NCS in the classroom environment. With this type of team work, different knowledge and understanding of the lesson presentation will improve the performance of learners at the end of FET band.

It was also found that teachers use physical science trial examination papers to do revision with learners. This sounded interesting as the revision helps learners to identify the mistakes committed in answering some questions and will further assist them to prepare themselves for the examinations well in advance. It is important that all work done by learners, for an example, class work, tests, assignments, homework and so forth, be assessed by the teacher concerned and feedback in the form of corrections be given to learners.

The NCS encourages every teacher to report a learner's progress to all stake holders at the end of each term. In that way feedback serves as guidance to learners before writing final examinations and it also help learners to improve their performance.

4.2.1.2 Learner involvement

The findings related to learner involvement indicate that learners were not actively involved in the lesson. It is very important that every lesson be well planned in order to provide ample provision for maximum learner involvement and participation. Participants was observed not involving learners to a maximum. Learners were not interacting with each other like writing and explaining what was written on the chalkboard. Sometimes learners argued about the solution of a problem but did not arrive to common answers.

This would mean that learners were not motivated and interested in what they were learning about. Interested and motivated learners are usually eager to participate actively in the learning situation. It would be difficult to prevent motivated and enthusiastic learners from participating in classroom activities.

In contrast, the DoE (1997:17) when explaining that outcome based learning is a learner-centered approach based on the belief that all individuals can learn. Therefore, a learner-centered method of teaching and learning is encouraged. The learning outcomes and assessment standards also emphasize participatory, learner-centered and activity-based education. They leave considerable room for creativity and innovation on the part of teachers in interpreting what and how to teach (Overview English, 2002:12).

According to DoE (1997a:17), there has been a shift in learning; this shift demands learners to become active participants in their learning process and are also expected to take responsibility for their own learning.

The importance of learner participation and involvement is based on the fundamental principle that meaningful learning results can only be obtained when learners take an active role in discovering concepts, meaning, relations, solution, general laws, definitions and propositions (Fourie 1995:216). In his OBE paradigm, Spady (1994:8) states that what and whether they learned successfully is more important than when and how they learned something.

It was also found that teachers dominated the whole lesson. Teachers dominates the lessons throughout and learners were not given chance to express themselves. It is, however, important that teachers create an environment which is conducive to learning in order to arouse the learners' interest and motivate them for learning.

Learner participation helps the teacher to identify learners with learning difficulties and who experience problems in grasping the learning content in general, which is, concepts, meanings and problems in particular. As the emphasis was on conceptual understanding, problem solving and application of knowledge, the kind of deeper learning envisaged by the NCS was to develop citizens who are able to transfer skills from familiar to unfamiliar situations (DoE 2003:5). This will help learners to participate in the technological and economic development of the country. Learners should find solutions to the problems by themselves. In other words, learners will develop skills, knowledge and attitudes that can help the society they are living in.

4.2.2 Classroom organization

Working in small groups is one way of ensuring active participation of learners. According to Center for Teaching Excellence, group work can be an effective method to motivate students, encourage active learning, and develop key critical-thinking, communication and decision-making skills. Without careful planning and facilitation, group work can frustrate students and instructors and feel like a waste of time (<http://cte.uwaterloo.ca/>). From the participant observations, it was found that teachers organize their classrooms accordingly. Learners were arranged in small groups that were easy to manage and support.

Teachers took efforts in arranging the class and creating a teaching and learning environment conducive and appealing to the learners. For example, there were posters of the Periodic Table on the wall as well as other science pictures such as the nitrogen cycle and contact process.

This finding is in line with the co-operative teaching and learning strategies. Co-operative learning accepted as one of the best practices in education (Cohen, Brody & Sapon-Shevin 2004:3; Galton & Williamson 1992:14; Johnson & Johnson 1993:154). According to these authors, learners are likely to achieve more when working co-operatively, that is, in groups in order to achieve a common outcome; than when they work individually. It has also been found that learners' self-esteem and motivation are improved by working with their peers. Furthermore, there are considerable cognitive benefits to working collaboratively and it is likely to contribute to enhanced achievement (Galton & Williamson 1992:30; Cohen, Brody & Sapon-Shevin 2004:3).

Classroom organization has an impact on classroom management and learning. The NCS advocates the use of constructivist teaching methods to ensure a more learner-centered classroom. Gravett (2001:201) states that constructivist teaching methods, such as co-operative learning, discussions, problem-solving and student research, rest on the assumption that learning is an active process of constructing meaning and transforming understanding. For most of South African teachers, NCS, OBE and constructivist ways of teaching are relatively new policies.

In some cases participants understand what the NCS policy entails, but cannot manifest this understanding in practice. Hargreaves, Sayed and Jansen (cited in Jansen 2001:242) refer to this as a “dislocation between policy vision and practical realities in schools and classroom which remains a problem”. The emphasis is that policies are not implemented by stakeholders.

4.3 Results of the semi-structured interviews

This section reports the results of data collected from the semi-structured interviews conducted with physical science teachers in the Sekhukhune district. A brief analysis and interpretation of data obtained from transcripts of individual interviews is given and supported by literature.

Following the coding of the participants' transcribed responses in terms of the main research questions and interview questions, the following five themes were identified: lack of knowledge and understanding of the concept 'integration'; evidence of integration within and across the subjects; the significance of teacher in-service training regarding implementation of the NCS;

challenges experienced by teachers with regard to integration; and teachers' views concerning integration as a principle of the NCS.

4.3.1 Lack of knowledge and understanding of the concept 'integration'

The findings regarding the knowledge and understanding of the concept integration reveal that participants lack a clear knowledge and understanding of the concept as required by the NCS. In trying to show their understanding, they define the concept integration with reference to the English dictionary instead of describing it as a principle underpinned by the NCS policy. Participants use words such as link, related and combination to describe the concept integration. For an example one of the participants gave the following description:

"I understand that integration is all about the link of two subjects with relevant context. Physical science and mathematics concepts are linked together in teaching."

Integration is one of the NCS key design principles. In this way learners experience the curriculum as linked and related. This gives coherence and support and expands their opportunities to attain skills, acquire knowledge and develop the attitudes and values that are encompassed across the curriculum (DoE 2003:5).

This indicates that some participants were not totally uninformed; they understand a little about integration. The NCS policy underpinned integration of different subjects, that is, integration across the subjects. For example, mathematics concepts can be integrated with physical sciences concepts.

This finding is corroborated by Adler, Pournara and Graven (2000). Adler et al (2000:3) identified three levels of integration namely: integration of various components of mathematics; integration between mathematics and everyday real world knowledge; and where appropriate, integration across the learning areas. From this point, the notion of integration across the subjects is very important. However, participants indicated that they do not have knowledge and the skills of integrating across the subjects. They only sometimes read the subject policy for guidance and knowledge acquisition.

Practically, implementation of integration across the subject is a major challenge for teachers and it is not easy for them to get it right. Apart from difficulty, participants indicate that they do not know the Learning Outcomes of physical science, including their number and how to achieve them in a lesson. This might be due to the fact that the participants were not involved in drawing up the learning programme for their subject 'physical sciences', they are just recipients of learning programmes and work schedules drawn up by experts. For participants to understand the notion of integration, it is important that they be involved in all processes so that they develop knowledge and skills of integration, that is, within and across the subjects.

4.3.2 Evidence of integration within and across the subjects.

The evidence of integration within and across the subjects revealed that a large number of problems in physical science can be presented while teaching different concepts of mathematics. It is kept in mind that knowledge of appropriate scientific concepts and principles of science is prerequisite in understanding those problems through mathematics.

It was also found that physical sciences influence the life sciences. This is one of the reasons why learning outcomes of life sciences are also integrated within the physical science lesson. Indeed participants must do more for their learners to fully understand advanced concepts of life sciences, for example to teach learners about 'enzymes' and how they govern the chemical reaction inside the cells. An enzyme is a concept in life sciences and chemical reaction in physical science. The concept works in both subjects. This shows integration across the subjects.

The importance of subject integration was also observed by Bell (1951), Erdman (2004) and Mbeki (2001: 2005). According to Bell (1951:2), conventional science topics such as energy frequently incorporate mathematics concepts such as equation. Bell (1951) further states that such a strong connection has even promoted mathematics to become, as Gauss refers, "the queen of Sciences". In the same vein, Erdman (2004:146-148) adds that there are many topics such as vector that appear in mathematics textbooks as well as science textbooks. In support of these views, the former State President of South Africa, President Thabo Mbeki, in his state of the nation report in 2001 and 2005 highlighted that since 1994 the new democratic government has emphasized the centrality of mathematics and physical sciences as a part of the human development of South Africa (DoE 2001:7).

There are still challenges regarding the understanding of the NCS policy and principles. Some participants indicated that integration within and across the subjects are difficult. However, the NCS has to be implemented. For the success and failure of the curriculum implementation, teachers have to play roles accordingly. It is important to equip teachers with relevant information about the NCS.

This will assist them to improve their perceptions, their skills, knowledge, attitudes and values, as well as their willingness and ability to implement the NCS. Avalon (2006: 2) states that what is expected of teachers is their willingness to undertake or implement what the system sets forth, and in this aim they will be supported as far as possible.

4.3.3 The significance of teacher in-service training regarding NCS implementation

The findings pertaining to significance of teacher in-service training revealed the following three categories: trained and untrained teachers; duration of training; and the type of training received.

It was also found that most participants did not receive in-service training on the principles of integration organized by the Department of Education. Participants, who claimed to have undergone training, viewed the training as insufficient as the training was only attended for few days or a few hours after school. Participants were, therefore, dissatisfied with the type of training they had received. One of the participants says:

“I cannot actually call this training as it was attended for few hours after school. We were informed about the NCS, whereas the NCS need more time and resources”.

To introduce a new curriculum requires sufficient time. Training which is done after school while teachers are exhausted by their daily work responsibilities is unfruitful. Teachers do not have a choice if the plan is from top-down managers. This was also found by the Review Committee.

The committee highlighted the issue of training and explained that if teachers are given a choice, they would like to have more workshops conducted by a specialist in the area and those workshops should not interfere with the normal running of school (Report 2009:55 -57). Time of training is still a major challenge to the government and it impacts on the quality of the NCS policy. Teachers have to be given enough training so that they can implement the NCS effectively.

In contrast to the time allocated for training, the Education Deputy Director General, Penny Vinjevold (1999) said:

“All provinces were in process of training teachers in the curriculum, teachers are undergoing five-days training, with full scale training to take place later”.

Based on the Deputy Minister's view, five-day long workshops were also insufficient according to most participants. If a presentation is not understood, all teachers are negatively affected and gain little from training. This was also one of the central findings of the Department of Education and Wits University Education Policy Unit. They found that training programmes, in concept, duration and quality, were often inadequate especially early in the implementation process. There is therefore, a need to increase duration of training. Participants wanted the Department to review the duration for training. All teachers are obliged to receive adequate training of the NCS to implement the NCS accordingly.

4.3.4 Challenges experienced by teachers with regard to integration

The findings show that the performance of learners in physical sciences since the introduction of the NCS has gradually deteriorated. Learners do not pass with outstanding marks at the exit of FET band. The poor performance in physical science might be caused by overcrowding and language barriers. Overcrowded classrooms disable teachers to control group work and provide individual learners with the necessary support. Learners with learning disabilities are generally weak in one subject or in aspects of various subjects. Secondary schools are experiencing an increase in enrolments to the extent that the teacher: learner ratio of 1:35 is no longer applicable. Participants explained that overcrowding in science classes hinder science teachers to meet the expectations of the NCS.

The other contributing factor is the language of instruction. The usage of English as a medium of instruction has a major impact on the academic performance of learners, their interest to learn a specific subject and the way they communicate with the teachers as well as fellow learners about different concepts of a subject. In most cases, English is the second or third language to most of the learners. English as a medium of instruction has been contested by some parents and educationists who argue that the learners' home language should be used for teaching and learning (Themane 1989:122). In a multilingual country like South Africa it is important that learners' reach high levels of proficiency in at least two languages and are able to communicate in other language.

The language subject statement (DoE 2002:2) follows an additive or incremental approach to multilingualism:

- All learners are required to learn their home language and at least one additional official language.
- Learners thus become competent in their additional language, while their home language is maintained and developed.

In addition to the language issue, participants indicated:

“Some word usages in physical science are not familiar with the situation of rural areas. Words such as, ‘lift and escalator’ in describing motion is too difficult to our learners. Learners cannot assimilate that word in the problem to be solved. Learners find themselves failing because of misinterpretation of some words.”

Based on the stated findings it is clear that the acquisition of knowledge and the development of cognitive, affective and social skills occur primarily through the communication process, between learners, teachers and learning materials (Makgato & Mji 2006:263). The terminology used in physical science sometimes shares a colloquial meaning and these results in misconception or at least confusion among second language speakers.

Teacher preparation is another challenge that affects the integrated method of teaching science in Grades 10-12. Poorly prepared teachers struggle to implement the NCS policy adequately and this hinders the correct lesson preparation. Teachers are required to use the learning outcomes as a focus when they make instructional decisions and plan their lessons. They encounter various problems ranging from lack of clarity regarding integration of learning outcomes in the NCS policy document. To enable teachers to provide an integrated teaching and learning environment, changes in teacher preparation are essential. Pang and Good (2000:73-82) write:

“The literature associated with teacher preparation and integrated mathematics and science education is laden with obstacles or barriers including philosophical and epistemological differences, teacher content and pedagogical knowledge, teacher perceptions and beliefs, school and administrative structure, assessment practices and appropriate instructional resource.”

Teachers, who do not integrate are missing opportunities to help learners to understand the world in which they are living.

It is important to establish how teachers deal with situations in which they are called upon to reflect on their scientific and mathematical knowledge during lesson planning and teaching. Teachers should think about integration across subjects, how integration may shape lessons and how to integrate across disciplines in actual classroom practice.

Beside teacher preparation, some teachers feel that the implementation of the NCS must be an all-or-nothing scenario. However, there may be instances in which integration is inappropriate. Overview NCS Grades10-12 (2002:55) states: "Teacher orientation and development will be one key challenge that faces implementation of the NCS Grades 10-12 (school)." In order to address this situation, a generic OBE teacher's manual and a subject-specific manual were developed to prepare teachers for the classroom in 2003. Thus, teacher orientation and development for transition is seen as the beginning of orientation and development for the NCS Grades10-12 (school).

It was also found that there is an increase in paperwork on behalf of teachers. Teachers do more administrative work than teaching. This finding is in line with what was confirmed by the Report of the Review Committee (October 2009:8) to the Minister of Basic education, Ms. Angela Motshekga. In this regard, Minister responded:

"Teachers across the country complained about onerous administration requirements and duplication of work. There must be reduction of teacher's workload particularly with regard to administration requirements and planning, to allow more time for teaching."

4.3.5 Teachers' views concerning integration as a principle of the NCS

The findings with regards to teachers' views indicate that some procedures need to be reduced, for example, learners' portfolios. Learner's portfolio needs too much paperwork. In other words there must be reduction of administrative work done by teachers.

It was also found that physical science should be separated into physics and chemistry for specialization from Grade 10 according to a learner's career choice. Participants were of the view that if the subject was separated, learners would perform better in both subjects and be in line with a chosen career. This should correspond with Higher Education (HE) curricula because in higher education, the subjects are separated as courses or modules according to different careers. For example, if a learner opts for civil engineering, he/she will major in Physics rather than Chemistry. Learners at this level no longer do Chemistry. It is important to consider the choice of subjects according to different career choices of the learners as early as in Grade 10.

The separation of subjects is also guided by the time allocated for subject teaching. The departmental time allocated for the subject is too little for both Physics and Chemistry. For teachers to complete the scope of the work, extra time is required. In physical science, some sections are more practical than theoretical. Teachers who teach the subject have to work longer hours to cover the scope for the subject. Some teachers do not complete the syllabus because they do not wish to work extra time, possibly because they receive not overtime pay. This impacts the performance of a learner. A participant who works extra time highlights:

"I have seen that without coming for morning and afternoon study there will be incomplete work schedule".

It is clear from the findings that to become a physical science teacher, one has to show commitment in his or her work. To cover the subject adequately,

physical science teachers have to sacrifice personal time as the scope is vast. One of the participants explained this idea clearly:

“Sometimes teachers don’t want to work extra time and the scope becomes incomplete. Incomplete scopes produce poor results. Teachers are on the view that they can’t work extra time that is not paid for. Some other department’s make claims on overtime they work for. In our department if you work over time, it will be for the benefit of learners to be able to pass and to further their studies. For the sake of learners let’s work over time until the department realizes that poor results are caused by some of the teachers whom don’t want to work overtime as time allocated is too little”.

Thus, sufficient time is required for the teaching of physical sciences and time allocated for the teaching of physical science should be reviewed in conjunction with the separation of physical science into Physics and Chemistry from Grade 10.

Further, summative assessment of physical science is done by two question papers: Paper one (Physics) and Paper two (Chemistry). It appeared that most teachers understand the content of one paper better than the other. A teacher may understand and love Chemistry more than Physics. These impacts negatively on the learners because teacher tends to concentrate more on Chemistry while Physics suffers with accompany effects on learners. It is recommended that these papers or sections are separated and taught by different teachers.

4.4 Focus group interviews

A focus group interview was used in this study as the third method of data collection. The focus group promotes self-disclosure among participants (De Vos 2002:207) and encourages different participant to share different viewpoints. The focus group consisted of eight participants: four teachers, three heads of departments and a deputy principal. The findings indicated a lack of understanding of the NCS subject policy, especially the subject policy document. Some participants have the policy but do not know how it works; others have not used it and are unaware of its purpose.

The subject policy makes provision for a well-organized and practically orientated programme in the teaching of physical science in the secondary schools and aims to provide guidelines for subject managers in controlling teaching and learning activities and in organizing their administrative duties and planning teaching and learning to meet the expectations of the national standards and performance (National Subject Policy Guide for Social Science, NIED, 2008:2). Subject teachers should regularly consult this document to ensure that they teach within the guidelines of the policy. The purpose of the document is to guide subject management in the school while simultaneously leaving scope for each individual teacher to take initiative, especially in presenting subject content and facilitating learning.

However, there are number of shortcomings associated with subject policy implementation; there was no clear and detailed implementation plan for the NCS policy. A participant confirmed:

“There is no guideline document that will help us to implement the NCS in the classroom”.

This created the space for participants to blend the NCS into Curriculum 2005. They developed their own interpretations leading to widespread confusion about what constituted official policy.

Some teachers understand the policy, but mistakenly adopt one or more of these roles exclusively, instead of integrating all the roles to develop a wide range of competencies on which they can draw at appropriate times to enhance practice. A more specific description of policy implementation is provided by Van Meter and Van Horn(1974: 447-8) when they state:

"Policy implementation encompasses those actions by public or private individuals (or groups) that are directed at the achievement of objectives set forth in prior policy decisions."

The major reason why teachers are unable to bridge the distance between policy and practice is that policy images conflict with teacher's identity as practitioners(Jansen 2002:118). Many teachers understand what the Norms and Standards entail, but cannot demonstrate this in practice (Harley et al. 2000:88).

What is evident in the literature is that the implementation of a policy, like the Norms and Standards for Educators, does not simply involve the policy instructions or replacing 'old' practice with 'new' practice, rather, implementation seems to be a process of fashioning the policy in such a way that it becomes part of the teacher's identity and ultimately part of his/her way of being (Hendricks 2008:22).

Taking into consideration the inadequacies of teachers regarding the implementation of policy, it is important to support teachers in their endeavor to cope with the NCS as part of curriculum reform. The successful implementation of new policy such as the NCS will only be effective if teachers are adequately prepared and equipped by means of training.

Andreson (2001:1) supports the statement by saying that it has become necessary to help teachers update their knowledge and skills to deal with changes on the hand and managing human resource better on the other. Central to this is teacher understanding of policy. The recent curriculum history has been characterized by radical change within a relatively short period and the result has been a high level of confusion amongst teachers around what they are expected to do.

The other finding revealed that integration of Learning Outcomes and an Assessment Standard is not understood and is not done within and across the subjects. In the focus group interview, a participant sought clarity on how learning outcomes and assessment standards are integrated and benefit the learners. The discussion revealed that teachers lack knowledge and skills for integrating learning outcomes and assessment standards.

They just met integrated learning outcomes and assessment standards in their learning programmes. The Norms and Standards document (DoE 2000:13) emphasizes the role of the educator as one who understands, interprets and designs learning programmes. Teachers need to design learning programmes in such a manner that learners will be encouraged actively to engage in the learning process. The idea behind the development of learning programmes stems from Curriculum 2005, where integration and the identification of common themes across a phase were privileged in planning. In the greater stipulation provided by the NCS, learning programmes have become somewhat redundant.

According to the Report (2009:26), the adoption of the idea of learning programmes has not been very successful. This has led to confusion among teachers who should match learning outcomes with assessment standards at the General and Education Training (GET) and FET levels. Teachers spend more time in interpreting learning outcomes and assessment standards. Thus, learners do not benefit and are not obliged to know learning outcomes and assessment standards of their subjects. However, an outcome is an instrument that measures whether learners have developed knowledge and skills at the end of the Grade or phase. Learning outcomes and assessment standards describe knowledge, skills and values that learners should acquire by the end of a band (DoE 2003:7).

Unsuitable resources, such as inappropriate textbooks, hindered the implementation of the NCS in the teaching of physical science. Textbooks have shallow information and some textbooks lack concepts relevant for Physics. For teachers to do preparation, they are obliged to use additional textbooks as a reference source for the teaching of some concepts.

Sometimes teachers become discouraged as this is time consuming. However, textbooks are crucial in supporting the implementation of curriculum. They aid curriculum coverage and make available the conceptual logic of the subject in question as it progresses through the set field of knowledge to be taught and learnt. According to the Review Committee Report (2009:52-54), the role of textbooks was subordinated to the idea that teachers should develop their own learning materials. The role of the textbook and other Learner Teacher Support Materials (LTSMs) should be communicated clearly to the teachers. Teachers should be encouraged to use nationally approved textbooks and teachers' guides for planning and classroom teaching to ensure that the curriculum is covered in a year.

The learning environment, such as rural areas, powerfully influences the knowledge and skill development of both teachers and learners. The problem of access to education in the rural areas is acute and in order to take on the enormous challenge involved in providing education for all, a more holistic view of education is needed. Education and training are two of the most powerful tools for rural development but are also among the most neglected aspects of rural development interventions by government. The diverse collection of stakeholders in rural areas requires education and training that differs from that available in the past. What is needed today is a broader educational approach serving the needs of diversified target groups and focusing priority on the basic learning needs of rural learners. In order to bring a significant change, education system reformers must appreciate the complexity of rural environment.

4.5 Conclusions

The findings in this chapter were presented under the main research question and relevant literature was integrated where possible. The findings are discussed in relation to participant observation, semi-structured and focus group interviews in order to investigate the impact of integration as the principle of the NCS in the teaching of physical science in Grades 10-12. The next chapter discusses the findings, conclusion and recommendations.

CHAPTER 5: FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter draws on the main findings discussed in Chapter Four. The conclusion regarding how science teachers can improve their integration skills are presented, and finally, possible recommendations are suggested.

5.2 Main findings of the study

The main findings of this study are classified under the research questions as outlined in Chapter 1, paragraph 1.2. These findings are further discussed in the following section.

5.2.1 Integration of different concepts within and across the subjects

Regarding integration of different concepts within and across the subjects, the main findings revealed that participants lack knowledge and understanding of the concept integration as outlined in the NCS policy document. Many participants found the lack of knowledge and understanding of the NCS policy to be a contributing factor to ineffective the NCS implementation in the classroom. This may be caused by lack of documents that provide clear guidelines on the implementation of the NCS principles, especially integration of concepts. This also suggests that there is no clear and detailed implementation plan for integrating concepts within and across the subjects.

From the participant observations, it is clear that integration of Learning Outcomes (LOs) and Assessment Standards (ASs) within and across the subjects was not effectively implemented in the lesson planning. LOs and ASs describe knowledge, skills and values that learners should acquire by the end of each band (GET and FET). This impacted negatively on the teaching and learning of physical science as teachers found it difficult to integrate physical science concepts with concepts in the other disciplines.

A lesson that shows the integration of concepts is still a dilemma for most teachers. Effective lesson implementation will only take place if lesson plans, lesson presentation and overall learner involvement are properly designed and developed in line with the national policy document. The planning should not just be in the area of planning, but, in essence, it must address the different aspects of planning: skills, knowledge, values and attitudes (SKVAs). To get this correct and implement it effectively, there is a need for proper understanding as well as acquiring necessary skills that will enhance the integration of concepts within and across disciplines.

5.2.2 The extent to which different concepts have been implemented

Regarding the extent to which different concepts have been implemented in the teaching of physical science, the main findings indicate that not all teachers have a clear idea of how to integrate the concepts. Few teachers indicated their expertise in correct practice. However, they were not aware of their expertise. From the participant observations it was clear that teachers did not refer to other subjects. For example, when teaching the concept energy in life sciences, the same concept was also taught in physical science.

This showed that teachers focused mainly on content rather than principles. The principle was not grasped by many teachers. Importantly, teachers should know the concepts and how they are related in different subjects. This will reduce learning problems that learners may experience in one subject and they will become innovative in all subjects.

Integrating concepts in different subjects is important for teaching and learning, especially the science subjects. The findings highlighted that most concepts appear in all the three (physical sciences, life sciences and mathematics) subjects. It follows that it does not help to teach the subjects in isolation from the others. It is better to treat the concepts together. For example, concepts that are related to both subjects (e.g., in applied mathematics, the same concepts are used as in mathematics) are also applied practically in physical science. Another practical example is in life sciences where the same concepts are also found in physical science.

5.2.3 Challenges teachers experienced when integrating different concepts

The whole idea of integration is a challenge to physical science teachers. Most teachers have not received in-service training on the principle of integration as organized by the Provincial Department of Education.

Insufficient time allocated for training as well as for the teaching and learning of the subjects itself is also a challenge. Teachers cannot cover the given scope of work as per given notional time. This affects the performance of learners negatively as the final examination paper addresses issues that were not dealt with in class.

As well known in the South African context, overcrowding is a major challenge for most education institutions. The findings highlighted overcrowded classes as an inhibiting factor that hinders teachers in equipping learners with necessary skills and providing individual attention. Similarly, the language of learning and teaching (LOLT) is a challenge to the teachers as some concepts are not grasped by learners. Where language is a barrier, effective learning of physical science does not take place. This contributes to the poor performance rate of learners who are taking physical science as a subject. Prescribed materials such as physical science textbooks have superficial information which is not useful to teachers and learners and often lack concepts relevant to physical science.

Due to the transformation in the South African education system, the role of the teachers has shifted to that of administrator. More time is consumed by administrative work rather than teaching and learning. These challenges impact negatively on the teaching of physical sciences in the FET band. However, teachers have a crucial role to play as agents of change. If teachers are to meet this demand, they need to be trained in the principle of integration so that they acquire a deep understanding of changes aligned to the curriculum, as well as the skills and attitudes necessary for the meaningful and creative implementation of change in their classrooms.

Poor support and monitoring are other contributing factors to poor learner performance. In most cases teachers are trained but could not get sufficient support and monitoring from principals, subject specialist and the Department of Education. This would mean that learners are not fully equipped with necessary knowledge and skills for the learning of physical science.

Infrastructure, such as science laboratories, are lacking in rural schools. Learners are unable to conduct practical science experiments; they only learn about experiments theoretically. This impacts negatively on their learning as experiments should be conducted in practice. If learners were able to conduct experiments, their learning would be consolidated. This is confirmed by the saying: “Believing is seeing” . .

5.3 Conclusion

The study focused on the impact of integration as one of the principles of the NCS in the teaching of physical sciences in Grades 10-12. The objectives of the study were discussed in Chapter 1 (see Chapter 1, paragraph 1.3). The study took place around Sekhukhune District in Limpopo Province and used eight secondary schools that offer physical science as its target population.

Several methods of data collection as outlined in Chapter 3, included participant observations, semi-structured and focus group interviews (see Chapter 3, paragraph 3.3.2.1). Data were analysed qualitatively using themes and categories to describe rich data and this was supported by theory (see Chapter 4).

From the data it was found that the integration principle has not been implemented in most schools in the Sekhukhune District. The researcher of this study sees it important for science teachers to empower themselves; teachers should not wait for the Department of Education to provide workshops. More importantly, teachers have to develop collaboration structures where they can work with other teachers of the same subject. This teamwork will help teachers to implement the principle of integration effectively in their teaching and learning activities. If teachers can develop the pedagogic content knowledge of the

subject, learners will also reap the benefits of learning physical science. Therefore, their performance will improve enormously.

This study indicated that the continuum model of integration (Science for Mathematics and Science for Science) as discussed in Chapter 2 is suitable for the implementation of integration based on the following:

- The integration of concepts across and within the subjects is illustrated clearly in the model.
- The model encourages team teaching approach (collaboration).

It is believed that if this model could be used and followed by teachers as a guiding principle for the integration process, integration will play an important role in the teaching of physical science.

5.4 Recommendations

Given the problem of the study as discussed in Chapter 1 paragraph 1.2, the findings of the study discussed in Chapter 4, the following recommendations are made subject to the following research questions:

Evidence of integration of different concepts within and across the subjects.

- The Department of Education should endeavor to train teachers in implementing the principle of the NCS in teaching physical science.

- Teachers are the most important educational resource that we have, and they will determine whether the national curriculum succeeds or not. Therefore, the success of the NCS in teaching physical science depends on the training, monitoring and support teachers receive and the ability to mobilize and manage time and resources to implement the curriculum.
- The appeal of effective training in the NCS for South Africa lies in its potential address of our critical and developmental problems. The emphasis in implementation should be on sustainability and the change roles of teachers and learners. Stakeholders should ensure that the national curriculum is sustainable. Issues rose surrounding the NCS should be dealt with courageously, innovatively and creatively. There is a need to learn and improve through consultations and participation.

The extent to which concepts are already integrated

- As the teachers have no idea of how to integrate concepts and taking into consideration the inadequacies of teachers regarding the implementation of policy, it is important to support teachers in their endeavor to cope with curriculum reform. In line with the new dispensation in South Africa, it is of utmost importance that effective professional development models be developed to empower teachers, so that reform based teaching and learning strategies are implemented in the NCS classrooms, in an attempt to enhance learner performance. Therefore, the success of the NCS depends on the training and support of teachers and their abilities to mobilize and manage the resources around them.

- For every newly introduced curriculum there should be proper training of teachers, school management team (SMT), subject specialists and curriculum advisors so that the curriculum can be sustainable.
- Support from all stakeholders is necessary. For proper implementation of a curriculum, after each training session, there must be support and monitoring.

Challenges experienced by teachers when implementing the principle of integration

- Time allocated for training should be increased. Training time should be increased to a year or six months with follow-up to check the implementation thereof.
- Time allocation for physical science is too short and extra classes in the morning or afternoon are required to finish the work schedule .Participants reiterated the need to separated physics and chemistry from Grade 10 to allow for specialization to allow learners to achieve in the choice made. This will support choices for future careers at the early stages of learning and reduce the high failure rate in physical science.
- Certain procedures in the NCS should be considered of lesser importance such as preparing learners' portfolios which is time-consuming. This will reduce administrative work.
- Principals must support teachers in using policy document correctly with the consultation of specialists. They must take overcrowded classes into cognizance and train teachers to deal with overcrowded classes.
- Attention should be given to the use of English as language of instruction and its impact on learner performance. It is advisable to use concepts that learners are familiar with in their environment.

- Textbooks with superficial information should be revised; textbooks with various examples or strategies should be used to understand and apply the concepts.
- Curriculum change requires proper planning and implementation. Policy designers should review methods of curriculum design and implement sustainable planning using standard procedures and format for review, not only when a policy fails.
- Physical science should be separated for specialization from Grade 10-12 as it is done at University level into Chemistry and Physics according to learner choice and in accordance with career choice in Grade 10. This will enable learners to excel in Physics or Chemistry at the exit of FET band.
- Laboratories should be built in every cluster in rural areas to give access to many schools. Laboratories should have a trained teacher to help all learners with experiments.

Research is also required to determine why the Curriculum and Assessment Policy Statement (CAPS) document does not include the principle of integration among other principles mentioned.

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APPENDIX 1

Enq: Ramokgopa M.S

Cell: 082 558 5001

P.O. Box 1200

Sovenga

10-09-2010

Principal and Science Educator

Phutlotau High School

Dear Sir/Madam

APPLICATION FOR CONDUCTING AN INTERVIEW

I hereby apply for conducting an interview at your school. The department approved the permission to conduct the research at your school. Letter of permission is included herein.

1 .Interviewee is educators who first identify their credentials as physical science teachers.

2. Interview will be conducted between 14h00 and 15h00. It will take only 30minutes between those times.

3. Date **08-10-2010**.

NB: Don't hesitate to contact me for clarity on that application.

I will be happy if my application is appreciated.

Yours

Ramokgopa M.S (Researcher

APPENDIX 2

INFORMED CONSENT FORM

Title of the study: The impact of National Curriculum Statement principle in teaching physical science in Grades 10-12 in Sekhukhune District.

Researcher: Ramokgopa M.S

Institution: UNISA

Background information

The ability to integrate subjects following the guidelines of the NCS raise a concern to most the teachers. Teachers are not adequately trained to handle new curriculum demands; however they are qualified in other disciplines. Integration is a key driving principle of the new SA curriculum. Transferring knowledge from one setting to another is always problematic. Knowledge and skills cannot neatly lift out of one setting and imported ready-to-use into a new setting. How one links concepts from one discipline to another depends on one's understanding of possibilities of connections that are available. The new curriculum needs teachers to follow the principle of integration as it was adopted in the constitution of the RSA (Act 108 of 1996) It is therefore important that teachers be trained on how to integrate different discipline.

Purpose of the research

Purpose of the study is to investigate how teachers integrate concepts in classroom situation.

Possible risks or benefits

There is no risk involved in this study except your valuable time. There is no direct benefit to you also. However, the results of the study will assist teachers to effectively integrate concepts in different discipline. Learners to become top achievers and also policy designers will benefits.

Confidentiality

The information provided by you will remain confidential. Nobody except researcher will have an access to it. Your name and identity will also not be disclosed at any time. However the data may be seen by Ethical review committee and may be published in journal and elsewhere without giving your name or disclosing your identity.

Available Sources of Information

If you have any further questions you may contact Researcher Ramokgopa M.S on following cell number 082 558 5001

AUTHORIZATION

I have read and understand this consent form, and volunteer to participate in this research study. I understand that I will receive a copy of this form. I voluntarily choose to participate, but I understand that my consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved on this study. I further understand that nothing in this consent form is intended to replace any applicable Federal, state, or local laws.

Participant's Name Printed.....

Date.....

Participant's Signature.....

Date.....

Researcher's Signature.....

Date.....

APPENDIX 3

Participant observation template

Time	Event	Impression
15:00	<p>I walked in the school administration office, greet the principal and remind him about the request of observation. The principal inform the school management that I came for the observation of lesson in the classroom with Physical Science teacher.</p> <p>Physical Science teacher was call to me.</p>	<p>The school principal welcomed me and calls his school management team. They were happy and gave me go ahead with the purpose of that hour.</p> <p>We greeted each other and move to the classroom.</p>
15:15	<p>I walked in the classroom with Physical Science teacher. He greeted the learners and introduces me to the learners.</p> <p>I greeted the learner and explained to them that they must not be shy to ask any question where they don't understand.</p>	<p>Learners were happy to see new face in their classroom</p> <p>They were participating in their lesson</p>
15:25	<p>The teacher introduces the topic of that day on the chalkboard.</p> <p>Questions were asked about the topic written.</p> <p>The teachers continue with lesson explaining the topic.</p> <p>Teachers invite some learners to</p>	<p>Learner were looking in front to the chalkboard seems listen to what the teacher was said.</p> <p>Learners raise their hand trying to answer questions.</p> <p>Some of the learner seems they don't understand.</p> <p>Some of the learners wrote</p>

	<p>solve some of the problem on the chalkboard.</p> <p>More physical science problems solving were given to solve on the chalkboard by learners while others do it in their scribblers and trying to check as whether they started to solve in it.</p> <p>The teachers continue with the lesson by involving his learner.</p> <p>The teacher gave learner class activities and homework based on what they were doing during lesson presentation.</p> <p>We move out of the classroom to staff room.</p>	<p>on the chalkboard while others in their scribblers.</p> <p>Learners started to develop interest of writing in their scribblers.</p> <p>They were listening to their teacher.</p> <p>They were actively involved in their learning and they copied homework. I gave further clarification on some concepts to learners.</p>
16:25	<p>I talk to the teacher to see his lesson plan and I produce my sample of lesson plan.</p> <p>Most of lesson plan there were no integration of Learning Outcomes and Assessment Standards.</p> <p>Most of the lesson plan was not in the format of NCS. It was just scribbling.</p> <p>Classrooms were well organized.</p> <p>I thank the teachers for the good work they were doing in their classroom and encourage each other to consult the policy and try to work as a team.</p> <p>I encourage them to use team work</p>	<p>The teachers were free to give me where they have written their lesson plan.</p> <p>The teachers seem not aware of integration as important.</p> <p>Integration within and across is a problem to them</p> <p>Learners were seated in small groups around their tables with their scribbler in front of them.</p> <p>Teachers appreciated the team work as important to them.</p> <p>Teachers were happy and</p>

	<p>were possible because it helps in understanding the topic better and discuss a good strategies of teaching that topic.</p> <p>I want to thank you all about the good work they have done with me and encourage them to do the same with other researchers. I just said bye to them all.</p>	<p>wish me to be with them a longer time.</p>
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APPENDIX 4

Semi-structured interviews

1. Do teachers integrate concepts within and across their subjects?

1.1 What do you understand by the concept 'integration' as one of the principles of NCS?

1.2 Have you attended any training on the implementation of NCS?

1.3 How do you implement integration as a principle?

2. To what extent have physical science concepts been integrated to other subjects?

2.1 Have you ever integrated your subject with other subjects?

3. What are the challenges experienced by teachers in the integration processes?

3.1 What challenges are you experiencing when integrating concepts in your teaching activities?

3.2 What advice would you give to other teachers concerning NCS and other educational policies?

APPENDIX 5

Focus group interviews

1. What do you understand by NCS policy specifically Physical Science?
2. How often is this policy visited for guideline?
3. Do you implement this policy in the teaching of Physical Science?
4. Is there any training received about the implementation of NCS policy?
5. Integration is one of the principles of NCS. How have you worked with this principle? Can you provide some examples of how you have illustrated integration within NCS in classroom situation?
6. How do you see the role of integration principle within the NCS?
7. Is LTSM important in NCS?
8. What are some of the challenges within the NCS?